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THE PROMOTION OF AGRICULTURAL SCIENCE.

THE Society for the Promotion of Agricultural Science was founded in the year 1880, largely through the efforts of a few men, most of whom have now passed to their reward, who saw clearly the necessity for some such organization.

At that time the workers in agricultural science in the United States were few and scattered. While the oldest of the agricultural colleges had been in existence for some twenty-five years, these institutions were still comparatively feeble, with, in most cases, few students, and struggling for recognition. The first agricultural experiment station in the United States had been established but five years before and had been fully taken over by the state two years later. At the date of the foundation of this society, there existed in the United States three state experiment stations, two university stations and one private station, and few means were available for personal contact or exchange of ideas between investigators or for the publication of their results. The U. S. Department of Agriculture was a comparatively small affair, presided over by a commissioner, and its scientific work was chiefly that of its chemist, entomologist and veterinarian.

The twenty-six years which have since elapsed have witnessed a phenomenal development of agricultural education and investigation, and the young student of the present day can hardly realize the conditions which existed a generation ago. Now,

instead of half a dozen experiment stations, with an aggregate income of about twenty-two thousand dollars, we have, in the United States proper, sixty institutions, with a total income for the year 1904–5 of over one and a half million dollars. The U. S. Department of Agriculture has grown from a staff of one hundred and eight persons and an annual income of somewhat over two hundred thousand dollars, in 1881, to a great executive department with a total appropriation for the present fiscal year of nearly ten million dollars. The land grant colleges, too, from feeble and more or less destitute 'cow colleges' have acquired an acknowledged and honored position among the institutions for technical education, with a total endowment of ever eighty-one million dollars and an annual income of over eleven and three fourths million, with faculties aggregating two thousand six hundred and seventy-two and giving instruction to a total of nearly sixty thousand students, of whom nearly nine thousand are students of agriculture. In place of a few scattered bulletins and reports, issued in small editions, the experiment stations and the Department of Agriculture have become great publishing agencies, and instead of its being difficult to find a medium for the presentation of the results of investigation, the difficulty more often seems to be to find suitable material for the numerous publications called for by law or popular demand. Finally, the organic unity of these institutions as a class has been secured through the Association of American Agricultural Colleges and Experiment Stations. Surely this is a magnificent record for a little over a quarter of a century, and the end is not yet.

With this stupendous change in the situation, it might almost seem as if there were no function remaining for a society like this. Are not all these public institutions agencies for scientific investigation in agriculture on a scale and with resources such as to make a private organization superfluous? Is it still necessary to promote agricultural science?

Let us at the outset define our terms. By agricultural science we understand that body of scientific principles, known or discoverable, which underlies and conditions successful agriculture. By the promotion of agricultural science, we may understand the support of any measures calculated to give us a deeper and more comprehensive knowledge of these principles. In other words, it is equivalent to the promotion of scientific investigation in the field of agriculture. Investigation is scientific, as distinguished from practical, when it is undertaken with the prime object of enlarging our knowledge of principles and without immediate reference to practical application. Its incentive is the desire to know more rather than the ambition to do more.

Few members of this society, certainly, will question the fundamental importance of such investigation. They realize the truth of a recent remark by Dr. Welch,[1] of Johns Hopkins University, at the dedication of the new buildings of the Harvard Medical School, that, "The same phenomenon is exhibited in (medicine) as in all science that the search for knowledge with exclusive reference to its application is generally unrewarded." Research forms the ultimate basis of all agricultural as of all other progress, whether in the school, the college, the correspondence course or on the farm. I may be permitted to further emphasize this truth by quoting the words of one whose standing both as a scientific investigator and as a successful administrator is universally recognized."

[1] Science, October 12, 1906, p. 460.

At the jubilee of the University of Wisconsin, in 1904, Professor T. C. Chamberlin, of the University of Chicago, said:

> The fundamental and ulterior sources of education do not lie in the conventional schools, but back of them. These sources can not here be defined at length, but, in a simple phrase, they may be said to lie in the great stock of ideas possessed by mankind. This phrase inadequately embraces the whole, but let us agree that it may stand for the whole. In so far as the stock of ideas of a people is narrow, defective and erroneous, on the one hand, or broad, demonstrative and exact, on the other, in so far the fundamental subject-material of education partakes of these qualities. In so far as the sentiments, beliefs, attitudes and activities of a people are narrow, loose and perverted, on the one hand, or free, generous and ethical on the other, in so far education inevitably shares in these qualities. For these are the fundamental sources of education. The basal problem of education is, therefore, concerned with the entire compass of the intellectual possessions of a people, and, in a measure, of all mankind. The special selections propagated in the schools are but a miniature reflection of the total possession, and this selection is usually noble or mean, as the whole is noble or mean.
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> If these considerations are true, the fundamental promotion of education lies in an increase of the intellectual possessions of a people, and in the mental activities and attitudes that grow out of the getting, the testing and using of these possessions.
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> The education of the individual does not necessarily lift the education of the aggregate, for if we convey to the rising generation only such ideas as we have inherited, the summit level of education is not raised. There may be diffusion, there may be an evening up, but no lifting of the upper levels. If the intellectuality of the new generation does not rise above that of the old, there is only a Chinese dead level of ancestral propagation.
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> To secure laudable progress in the fundamental conditions of education, systematic provision for scientific research is necessary.

Granting now the need of scientific investigation in agriculture, as in other branches of human activity, let us inquire what are some of the conditions which favor or hinder it. A recent writer,[2] describing the 'needs of scientific men,' says:

> We neither expect scintillating 'success,' nor do we look forward to any prizes in the way of highly paid positions. Our needs are mainly two: (1) adequate time for work and (2) a living wage.

After mentioning two instances of the lack of time for scientific research among his acquaintances, he continues:

> The difficulty is intimately connected with the other one, that of the living wage. There is no living wage for *research;* research in pure science is at present a parasitic industry, to borrow a term from the economists. Both of the men I have just referred to get their salaries for doing economic work, and whatever they do in pure science is supported and made possible by the other. A still larger body of researchers lives upon the proceeds of teaching, while those who *actually get a living by research* are very, very few. The experiment stations, even, do not disobey the general rule, for the demand for immediate results of economic value is such that the workers are almost obliged, in the majority of cases, to desist from work of a broad and fundamental character, while most of them, of course, have to do a large amount of teaching.

In this last sentence there is indicated the serious danger that threatens agricultural research in the United States. Even a very cursory review of the changes of the last twenty-five years shows a wonderful record of progress on the material and practical side. We have vastly increased our equipment for agricultural investigation and added many-fold to the numbers presumably engaged in it, but it is the output of real scientific results, which will stand the test of time, commensurate with the increased facilities.

The agencies for agricultural investigation which have made such a phenomenal growth in the last quarter of a century were at first looked upon with suspicion or distrust by the public. They had to demonstrate their right to be supported from

[2] Cockerell, SCIENCE, August 11, 1906, p. 178.

the public purse, and to do this were compelled to take up first the pressing practical problems and to give research a secondary place. But their very success in demonstrating their usefulness, as shown by their increasing appropriations and by the change in the public temper familiar to all of us, threatens to be their permanent undoing as agencies of scientific research. From an attitude of skepticism the public has passed to one of undue credulity, and the experiment stations today have need to heed the ancient warning, 'Woe unto you when all men shall speak well of you! for so did their fathers to the false prophets.' Indifference has given place to urgent demands for assistance, and the pressure upon these institutions for facts of immediate practical utility, which shall justify to the public the liberality with which they are supported and lay the foundation for greater appropriations in the future, is so intense as to require unusual courage and breadth of vision on the part of him who will stand for the needs of real scientific investigation.

The ever-present tendencies toward premature and sensational exploiting of results and towards officialism in science are likewise dangers which need constantly to be guarded against. A recent writer, speaking of the reasons why agricultural science is often discredited with the practical man, says:

> Science, too, is sometimes responsible for another form of apparent contradiction (between the results of science and those of practical experience), many of her representatives being only too much inclined to generalize the results obtained in a special case, and in particular to publish prematurely. This error is more or less fostered both by officials and by agricultural organizations. When a report must be published yearly upon all sorts of scientific work, whether completed or not, in which case 'results' are naturally expected and planned for, there is produced a literary ballast that is a burden upon scientific work and which carries with it the serious danger that the agricultural public, before which these unripe fruits are zealously spread by the agricultural press (especially in the case of official reports), will feel the evil effects in its purse and will lose its appetite for all scientific results. The subsequent continuation of the investigations then develops the limitations, corrections and specializations and the unripe conclusions are altered or sometimes even entirely overthrown and admitted to be erroneous. This is most injurious to practical agriculture, and has already led to great losses and brought science into deserved disrepute.
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> In my opinion it is not at all essential to bring new achievements before the general public with the utmost promptness and to publish as much and as speedily as possible, but rather that all which is published shall be trustworthy and securely grounded, not only by individual investigation, but, as far as circumstances demand, by the due mention, consideration or critical discussion of whatever other investigators have previously said and discovered concerning the subject. Nowadays, the haste for publication has made it actually the fashion in many circles to ignore the available literature, or to pirate it, and to act as if one were the first who had laid this egg. It is often the case, too, that the reader is supplied only with summaries or other average or final figures, while all deeper insight into the course of development and the details of the investigation is prevented by their silent omission. This method of publication is unscientific and superficial, and he who uses it, especially when he avowedly substitutes the authority of his name, does not perhaps realize how great is the presumption toward the reader of which he is guilty in such a method of presentation.
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> The unholy thirst for notoriety, too, has alas struck deep root in agricultural science and has developed such vigorous shoots that it has become a shame for those who are guilty of it and has fairly compromised our science. Unfortunately, no one has yet been found to duly scourge and pillory the false and unscientific nature of these methods.
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> All these growing evils are signs of degeneration. Let us guard ourselves against further cultivation of appearances and externalities. It is high time that modest, quiet, genuine work should take the place of this haste and false ambition, for agricultural science, as a relatively young science, stands in much too exposed a posi-

tion, in relation both to other sciences and to agricultural practise, to permit itself such laxities.

I quote these words from an article[3] by Professor von Rümker, of the University of Breslau in Germany.

Moreover, the agricultural experiment station in the United States has developed to a degree almost unknown in the land of its birth.

Twenty-five years ago the conception of an experiment station was that of a comparatively small institution exercising a police control over the manufacture and sale of certain agricultural products, notably fertilizers, and carrying on scientific research largely by laboratory methods. To a considerable degree this conception still obtains in foreign countries, but in the United States the stations have had an unexampled development. They are rapidly growing into great departments, touching the practise of agriculture in their several localities at all points, and the leaders in a vast propaganda for the elevation of rural life. We feel a just pride in this peculiarly American development of an adopted institution, and in the large measure of success which has attended it, but it would be foolish to shut our eyes to the accompanying dangers, and not the least of these is the drying up of the sources of power and inspiration by the failure to duly promote science along with practise. Not only does the pressure for results tend to the subordination of the scientific to the practical, but the management of these great institutions is making heavier and heavier demands on the time and energy of some of our best men. In fact, we seem to be developing a new type of leader in agriculture, comparable with the university president, who is primarily an administrator and whose chief function is to set other people at work. All honor to the successful administrator. Through his administrative work he is often a most efficient promoter of science. But let us not forget also to see to it that our system provides due honor and reward for the successful scientist and investigator. While the American type of experiment station is an admirable institution, and while the popular work of the stations and colleges is of vast importance and benefit, we must not forget that it all rests on the truths of science, and that unless science makes progress the popular work will soon be marking time.

The year 1906 has witnessed a notable forward step in the development of agricultural investigation. The passage of the Adams act has doubled the United States appropriation to experiment stations, nominally in five and practically in four years. This fund differs from the Hatch fund in that the act specifies that it is to be used only for 'conducting original research or experiments.' It is not too much to say that the great opportunity offered by the passage of the Adams act, which has been the occasion for so much congratulation, will, like every other opportunity, prove also to be a day of judgment for the stations, in that it will reveal to all men their conception of original research, and demonstrate whether or not they have a broad fundamental grasp of the idea of investigation. Differences of opinion regarding the application of this fund are already apparent. The stations stand at the parting of the ways. Will they simply add demonstration to demonstration, propaganda to propaganda, or will they grasp the opportunity to dedicate this new fund sacredly and irrevocably to original scientific research, broadly conceived and liberally executed.

I shall, no doubt, be characterized as an idealist, as failing to recognize or appre-

[3] 'Landwirtschaft und Wissenschaft,' Berlin, Parey, 1905.

ciate the need and the demand for popular work. An idealist I am and such I hope to remain, but I too know something of that desire for results and of that lively sense of appropriations expected which seldom fails to make itself felt by the station administrator. The situation is by no means without its difficulties, especially for those stations which exist to so large an extent under pioneer conditions. Were it otherwise, there would be little occasion for these remarks. The problem calls for strong men with an abiding faith in the fundamental and ultimate importance of scientific research. There is still need for the promotion of agricultural science. Times have greatly changed since a dozen gentlemen met in Boston in August, 1880, and founded this society, and some of the functions on which emphasis was then laid are now of less importance or have been otherwise provided for, but the great underlying purpose of the society, as expressed in its name, far from diminishing in importance has become even more vital to real progress.

What, then, may a voluntary organization, such as this, hope to do to promote agricultural science?

At no time since the society was founded has there been greater need for maintaining and raising the ideals of what science is and of what constitutes research. We are suffering to-day from a low and inadequate conception of scientific investigation. Now the conception of scientific investigation which is popularly current at any time depends very largely upon the attitude and ideals of the men of science themselves. The stream rarely rises higher than its source. It is of prime importance, therefore, that those professionally engaged in investigation in agriculture, whether in the experiment stations or elsewhere, should cherish a high ideal of their function in the body politic, and a high standard of professional and personal obligation. How can such ideals be more effectively maintained than by association. Scattered over three million square miles, and more or less isolated, we inevitably feel in our daily work the drag of the commonplace, the tediousness of the necessary drudgery which makes up such a large part of investigation, the temptation to cater to popular applause. What greater inspiration can we have than that which comes from an annual gathering such as this, where we meet, not as chemists or botanists, or entomologists, or directors, but simply as seekers after truth? Is not the mutual support, the discussion, the friendly criticism, which we encounter here a priceless factor in promoting agricultural science? In the conventions of the Association of American Agricultural Colleges and Experiment Stations, we meet officially, and seem tending more and more to the discussion of official and administrative problems. It is well to retain a meeting place frankly devoted to idealism.

But I believe the society may have other functions besides maintaining the ideals and strengthening the enthusiasm of its members. While it is essential that we maintain right ideals ourselves, it is equally important that we secure their acceptance by others. Few of us are so fortunate as to be able ourselves to defray the expenses of our own investigations. Most of us are dependent for the necessary funds upon the approval of boards of trustees or other superior officers, or, since these usually represent the public, we may say that we are dependent upon popular approval or at least tolerance. That research may take its rightful place, the public must come to understand better than it does the nature of research and its importance from the point of view of the general welfare.

Should not individuals and societies which stand for the promotion of science, while giving no less attention to specific results of investigation, take greater heed to the formation of an enlightened public opinion? We listened with pleasure and profit this afternoon to a discussion upon agricultural science in the experiment stations. Might it not be possible in the future to attract greater audiences to such discussions, and by means of suitable publication to bring them before the larger public? I feel sure that all legitimate influences ought to be brought to bear, whether in this or in other ways, to secure a generous and proper recognition of the importance of real scientific investigation in the work of our institutions for agricultural education and experimentation.

But such education of public opinion can not be effected in a month or a year; it must be a work of time, a gradual leavening of the lump. For the present, we can hardly expect otherwise than that the practical, so called, will predominate over the scientific in institutions supported by public funds. We are led to ask, therefore, whether any more immediately effective measures for the promotion of agricultural science can be devised.

Our minds naturally turn, in this connection, to the much-discussed question of the endowment of research. During the last few years we, along with others, have applauded the devotion of vast sums to this purpose, such as, to name two conspicuous examples, the endowment of the Carnegie Institution of Washington and of the Rockefeller Institute for Medical Research. We have rejoiced at the testimony afforded by these magnificent gifts to the estimate put upon the value of science and scientific investigation by hard-headed, successful men of affairs. We would not, if we could, subtract one dollar from the sums assigned by these and other like foundations to the support of any line of scientific inquiry, however abstruse. At the same time, we can not but regret that the great basal industry of this, as of every civilized country—the one which not only overtops all others in magnitude as measured in terms of money, but the one whose followers constitute the great conservative force of our national life—has thus far practically failed of recognition, and that the claims of agricultural science as a field for research have not thus far seemed to appeal to our men of wealth. I can hardly believe that this state of things will continue indefinitely. Wealth almost incalculable is being created annually by the American farmer, not for himself alone, but as well for the great transportation and manufacturing interests whose prosperity depends so directly upon his. Is it not reasonable to anticipate that if the importance of fundamental research in this field were properly set forth, free from the suspicion of personal interest, as it might be by a society like this, the Carnegie or the Rockefeller of agriculture would in due time appear, and that the great endowed universities would find a place for it in their programs?

These, then, are some of the larger objects which, as it seems to me, a Society for the Promotion of Agricultural Science should set before itself:

1. To aid in maintaining among our investigators in agriculture the highest ideals of scientific research, and to help to furnish the inspiration for the pursuit of these ideals.

2. To seek to educate the public to a greater appreciation of the need for scientific investigation into the underlying principles of agriculture and to a realization of the practical benefits flowing from it, and thus to promote the cause of agricultural

science in the experiment stations and kindred institutions.

3. To seek to impress upon university authorities, and upon wealthy donors, the claims of agricultural science to recognition as a most promising and attractive field for the endowment of research.

Is it not by setting before ourselves ends like these, even though they may seem somewhat utopian, that we shall most effectively promote agricultural science under existing conditions, rather than by simply meeting annually to read a few technical papers, too often prepared from a sense of duty or at the solicitation of the secretary, and paying a tax of two or three dollars to cover the cost of publishing them to an unappreciative world?

Finally, if the ideas which I have been advancing be not entirely quixotic, they suggest, to my mind at least, a radically different basis of organization from that which has prevailed hitherto.

At the outset, membership in this society was limited to forty, and the avowed purpose was to include only those who had already attained some degree of distinction in agricultural science. The idea in the minds of the founders, although nowhere perhaps clearly expressed, seems to have been to make membership in the society a distinction to be coveted. It was to be an American academy for agriculture, a sort of 'forty immortals.' Subsequently, the limits of membership have been greatly enlarged, yet in general the original conception has been adhered to, although not without struggles and heart burnings.

That conception was a high and worthy one, and that it has contributed notably to the promotion of agricultural science none can doubt. All honor to the men who at that early day embodied it in a concrete form.

But there is no impiety to their memory in asking whether the original form of organization is that best adapted to the changed conditions of the present day. Personally, I do not hesitate to say that I question this. The spirit of science is democratic and not aristocratic. In upholding her interests we need the help of everyone who has seen and loved her fair face. The man who has devoted half a lifetime to her service may be assumed to know and prize the modest rewards she offers. It is the young man, at the threshold of his career, dazzled by the glittering promises of business or commercial life, that we need to reach. If the society's influence is worth anything—if it affords any stimulus to worthy endeavor in the search after truth for its own sake—should not he especially have the benefit of it?

Moreover, why should we despise the aid of the man of affairs? If the promotion of agricultural science is also the promotion of the general weal, should we not rather welcome him as a new and powerful force through which to influence public opinion?

In brief, if the society accepts a comprehensive view of its mission, should it not make its basis of membership correspondingly broad, imposing no test except that of belief in the purposes of the organization and willingness to aid in forwarding them? It would still be possible to make a distinction, which need not be invidious, between those professionally engaged in agricultural science and those merely interested in its promotion on broad grounds of public policy, while the effectiveness of the society as an agent of propaganda would be immeasurably increased by such a broadening of its membership. The advantages of mere numbers, too, are not altogether to be despised. A larger membership, and more ample means, would bring within the range of possibility various

means of advancing the purposes of the society which now are entirely beyond our reach. The question of publication, for example, might present quite a different aspect under such conditions. The offering of prizes for the investigation or literary discussion of specified topics, the recognition by medal or otherwise of specially deserving investigations, even small grants in aid of research, loom up dimly on the horizon of possibility, but can not be further discussed here.

I am well aware that these suggestions may appear revolutionary. I have little faith in revolutions as a means of progress, but they have occasionally been unavoidable. We may as well frankly face the fact that for several years our society has been groping for a mission and that its meetings have been supported more or less from a sense of duty. I am not so presumptuous as to assume that I have found that mission. If my words serve to stimulate discussion and reflection concerning the functions of the society, they will accomplish all that I have any right to hope. True, we should beware of losing the substance while grasping the shadow, but, on the other hand, tradition should not blind us to the changed conditions confronting us. Are we not imperatively called upon to attempt in some way to make the work of this society such that the leaders of agricultural progress shall feel it worth their while to contribute to it liberally of their time and energy? If we can solve this problem we need have no apprehensions regarding the promotion of agricultural science.

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SCIENTIFIC BOOKS.

Soils. Their Formation, Properties, Composition and Relation to Climate and Plant Growth, in the Humid and Arid Regions. By E. W. HILGARD, Ph.D., LL.D., Professor of Agriculture in the University of California and director of the California Agricultural Experiment Station. The Macmillan Company. 1906. 8vo. Pp. xxvii + 593; 89 figures, including 37 photographic illustrations. $4.00 net.

In the production of this volume on soils Dr. Hilgard has enriched agricultural science throughout the domain of its most basal problems, and to a very notable extent. Moreover, its appearance at this time is extremely opportune, coming as it does with the initiation of more rigid research work by the agricultural experiment stations, before the Bureau of Soils has been able to fully discern what should be its own precise problems, and when the materials for agricultural education have yet to be definitely brought together in proper pedagogic form. It is now more than fifty years since Hilgard began the application of rigid research methods to the elucidation of the processes and principles which underlie and determine the productive power of soils. During most of this long period soil problems have been uppermost in his mind and have drawn from him, to their illumination, a large measure of his research effort. With mental traits of the highest research type; broadly and thoroughly trained at Zurich, Freiberg and Heidelberg before the days of extreme specialization in education, he entered upon this, his life study, with the best of equipment. Thrown directly into the field upon the humid, washed and leached soils of the south, from 1856 to 1872, in his agricultural and geological survey of Mississippi; then transferred to the glacial soils of Michigan from 1873 to 1875; and finally, for more than thirty years, studying the arid soils of the Pacific slope, during which time he was also attached to the agricultural division of the Northern Transcontinental Survey, and again brought back to reconsider the humid soils of the south when making his extended report upon cotton production for the tenth census, it is doubtful if any man living has been brought so persistently, widely and intimately to the personal study of soil types and soil conditions as he. And when it is

understood that throughout all of these extended studies soils have been considered broadly (1) from the standpoints of geology and climate; (2) from that of their physical composition, condition, moisture and aeration; (3) from that of chemistry and plant nutrition; (4) and finally from that of the correlation of native vegetation to virgin soil conditions as indicative of relative productive power a very important contribution to agricultural science may well be anticipated as the outcome of such preparation, especially when, as is the case here, the author fully avails himself of other investigations in setting out the subjects discussed.

Another feature which must give special importance to Hilgard's views as guardedly presented in this volume is the fact that throughout his half century of study he has been able to deal almost entirely with soils in their unfertilized or entirely virgin condition, whereas the whole of the soil literature of Europe had grown up on fields centuries old which had been long fertilized before the studies began; and what is more significant, our author, from the outset and throughout, was keenly alive to the fact that he was dealing with fundamental conditions which must be widely different from those which European students have met and from which they have drawn their conclusions.

The author groups his subjects into four parts: (1) the origin and formation of soils, covering 79 pages; (2) physics of soils, to which is devoted 237 pages; (3) chemistry of soils, appropriating 131 pages and (4) soils and native vegetation, to the consideration of which are given 62 pages. Those who have been in the habit of attributing to Hilgard the view that physical properties and conditions of soils play but a small part in determining their productive capacity will be surprised at the amount of space devoted to soil physics. This is done, not because of any change of views on the part of the author, for throughout all his writings no one has been more insistent regarding the greatest importance being attached to proper physical conditions as the first essential to a productive soil; and no one in America has done as much as he to establish the causes of the physical differences in soils which are productive and which are unproductive, and to point out practicable methods for correcting evils when they are known to exist. It has been his strong insistence during these later years, when it has become a fashion to ignore chemical differences, that these too are very important in influencing productive capacity, that has given the impression to some that Hilgard regards physical differences as of comparatively slight moment.

In Chapter I. the physical processes of soil formation are discussed, followed in the second by a presentation of the chemical, which includes the exchanges of bases in zeolites and the action of plants and their remnants in soil formation. Next come two chapters treating first of the major soil-forming minerals and then of the chief soil-forming rocks, where special stress is laid upon the nature, origin, determination and importance of colloidal clay as greatly influencing both the physical and chemical nature of soils; while in the last chapter of Part I. the minor minerals and ingredients of soils are treated, including those used as fertilizers and also those which are unessential or are injurious.

Part II. begins with the physical composition of soils and 'since clay is the substance whose functions and quantitative proportions influence most strikingly the agricultural qualities of land' it is first discussed. Then follows an important characterization of sands in humid and in arid regions, showing why the latter are usually and naturally so much more productive; the chapter closing with the methods, purposes and importance of mechanical analysis of soils. Chapters VIII., IX. and X., treating of soils and subsoils from the standpoints of causes and processes of differentiation; of organisms influencing soil conditions; of their relations to vegetation, and of the origin, nature and distribution of humus, will be found among the most luminous, important and suggestive, to both the student and the investigator, of all the valuable presentations which the book contains. Especially instructive is Fig. 27, contrasting a type of eastern soils with two of those of

California, showing the great differences in depth of the soil proper, thus giving a basis for understanding the possibility of deep humification, nitrification, root feeding and high duty of soil moisture which distinguish arid from humid soils, making them relatively more productive and more enduring. Chapters XI., XII. and XIII., in all 78 pages, are devoted to the water of soils, placing the greatest emphasis upon the problems of semi-arid and arid regions, while the remaining three chapters of this part deal with the absorption of solids from solution, and gases, the color of soils and climate.

Part III. is an extremely cogent and clear presentation of the author's and others' observations and conclusions regarding the legitimate functions, possibilities and utilities of chemico-physical investigations of soils in regard to crop production. A careful study of these chapters will be found a speedy and complete antidote for that miasma which rose up out of Maryland, infected the national capital and, on the wings of publicity, is developing 'toxic' symptoms at widely separated centers. The first chapter of this part, among other matters, gives a brief historical review of soil investigations; calls attention to advantages for soil study offered by virgin lands; points out the physical and chemical conditions of plant growth; discusses the solvent action of water upon soils; the ascertainment of immediate plant food requirements and chemical tests of immediate productiveness. The second chapter treats of the analysis of virgin soils by extraction with strong acids, the limits of adequacy of the several plant-foods in virgin soils and the influence of lime upon soil fertility, wherein it is held that 'a lime country is a rich country.' The next two chapters are given over to a very fruitful comparison of the soils of arid and humid regions, in which tropical soils, so far as data are available, come in for their share of consideration. The last two chapters of Part III., on alkali soils and the utilization and reclamation of alkali lands, all very comprehensive and practical discussion of those problems which must prove very helpful to agents of the reclamation service and to actual and intending settlers on those lands, 62 pages being very wisely given over to these important matters.

Soils and Native Vegetation is the title of Part IV. Quoting, but not consecutively, the author says:

> In newly settled countries, and still more in those yet to be settled, the questions of the immediate productive capacity, and the future durability of the virgin land are among the burning ones since they determine the future of thousands for weal or woe. This need has long ago led to approximate estimates, made on the part of the settler, by the *observations of the native growth, especially the tree growth.* * * * Thus in the long-leaf pine uplands of the Cotton States, the scattered settlements have fully demonstrated that after two or three years cropping with corn, ranging from as much as twenty-five bushels per acre the first year to ten and less the third, fertilization is absolutely necessary to farther paying cultivation. * * * Corresponding estimates based upon the tree growth and in part also upon minor vegetation, are current in the richer lands also. The 'black-oak and hickory uplands,' the 'post-oak flats,' 'hickory bottoms,' 'gum bottoms,' 'hackberry hammocks,' 'post-oak prairie,' 'red-cedar prairie' and scores of other similar designations, possess a very definite meaning in the minds of farmers and are constantly used as a trustworthy basis for bargain and sale, and for crop estimates. * * * Since the native vegetation normally represents the results of secular or even millennial adaptation of plants to climatic and soil conditions, this use of the native flora seems eminently rational. * * * It seems singular that such well and widely understood designations and important distinctions should not long ago have been made the subject of careful investigation and precise definition by agricultural investigators. For apart from their practical importance as guides to the purchaser of land, or settler, this correlation of land values and natural vegetation is of the utmost interest in offering an opportunity for researches on the factors which determine the choice of these several trees and their corresponding shrubby and herbaceous growths. * * * Only very fragmentary and casual observations in this line are on record thus far. * * * Yet, to ascertain by the physical and chemical examination of soils what are determining factors of certain natural vegetative preferences, which are invariably followed by certain agricultural results, should not be an unsolved

problem and its practical importance should justify its most active investigation.

The author gives in some detail, fully illustrating his thesis, the results of his early studies in Mississippi along these lines, presenting in Figs. 79, 80 and 81 the most striking illustrations of how individuals of one and the same species of post-oak, black-jack oak and deciduous cypress persistently differ in both stature and habit of growth when they recur on the same soil types in different localities throughout the state; finally extending the discussion to observations in the United States at large and to Europe. I can not do better, in closing the review of this valuable work, than to quote again the author where he is discussing the influence of lime in the soil on the character of floras.

What is a calcareous soil? The definition adopted for this volume has been given in a previous chapter; viz., that a soil must be considered calcareous so soon as it naturally supports a calciphile flora—the lime vegetation so often referred to above and named in detail. Upon this basis it has been seen that some (sandy) soils containing only a little over one tenth of one per cent. of lime show all the characters and advantages of calcareous soils; while in the case of heavy clay soils, as has been shown, the lime-percentages may rise to over one half per cent. to produce native lime growth.

At first thought it may appear to some that the adoption of such a definition is a subterfuge to make observations harmonize with theory, but it is not so. Every one will agree that a moist soil, defining it from the standpoint of plant nutrition, is one which will yield moisture to a plant as rapidly as it is needed. On this basis a sandy soil containing 4 per cent. of moisture is as moist as a clay soil carrying 20 per cent., the physiological difference being determined chiefly by the relative amounts of internal soil surface in the two cases.

This volume should be introduced to a much wider circle of students than those of the agricultural colleges generally. It will be found well suited to serve as the foundation of important seminars in chemistry, in geology and especially in plant physiology and ecology.

F. H. King.

October 30, 1906.

HATCH AND CORSTORPHINE'S GEOLOGY OF SOUTH AFRICA.[1]

The visit of the British Association to South Africa was the occasion for the appearance of two noteworthy books on the geology of that region: Rogers's 'Geology of Cape Colony,' and Hatch and Corstorphine's 'Geology of South Africa.' The latter is the more general of the two, as it treats of much the larger area; the former is somewhat more detailed, as all of its space is devoted to the formations that occur in the single colony with which it is concerned.

The small geological map, scale, 1:5,000,000, which serves as frontispiece to Hatch and Corstorphine's book, provides a good introduction to the problems considered in the text. The greater part of the area described is occupied by the nearly horizontal beds of the Karroo system, a vast body of continental deposits which has shared the fate of other stratified formations not containing marine fossils in having been explained by earlier observers as a lacustrine deposit, but which is now recognized as of mixed origin. Its lowest member is the famous Dwyka glacial conglomerate, or 'tillite,' as Penck has suggested it should be called, unquestionably of glacial origin. The overlying members of great thickness are probably of mixed fluviatile and lacustrine deposition, as they contain beds of coal and fossils of reptiles, as well as numerous dikes and sheets of dolerite. This great body of continental formations occupies a geosynclinal basin, some 600 miles east and west by 400 miles or more north and south. It is obliquely truncated by the seacoast on the southeast; there the ancient lands from which the basin deposits were derived, appear to have been lost in the Indian Ocean. On the south, the Karroo system and the underlying formations are folded in long east-and-west anti-

[1] Macmillan, 1905, 348 pages, 2 geol. maps, 89 figures and plates. $7.00.

clines and synclines which present in structure and topography many resemblances to the Alleghenies of Pennsylvania. The older formations here involved include many sandstones, of which the Table mountain series is the basal and heaviest member. The very ancient Malmesbury series, under the Table mountain sandstone, is presumably of Archean date; it consists largely of slates, with bodies of intrusive granites. This fundamental complex is exposed chiefly to west of the Karroo basin, as far as the Atlantic. A recent paper by Rogers, of the Cape Colony survey, announces the discovery of a very ancient glacial deposit, much more indurated than the Dwyka tillite, in this series of fundamental rocks.

The older formations that underlie the Karroo system in the Transvaal, on the north, are much more complicated than those on the southwest. Beginning at the base there are Archean schists and slates, with granitic intrusions; over these comes unconformably the Witwatersrand system, famous for its gold-bearing Banket or pudding-stone; then follows after a second unconformity the Ventersdorp system with heavy amygdaloids; and again after a third unconformity, the Potchefstroom system. This entire complex series was deformed by folds of moderate intensity and greatly eroded before a northern equivalent of the Table mountain sandstone, called the Waterberg sandstone, was deposited; and this in turn was heavily eroded before the first member—the Dwyka tillite—of the Karroo system was formed. A geological map of this region by Hatch on a scale of 1:1,250,000, is given at the end of the book.

The younger rocks are chiefly of Cretaceous age, near the southern and eastern coasts. The 'pipes' of diamond-bearing volcanic rocks are also younger than at least some of the Karroo formations, inasmuch as the Karroo members are cut through by the pipes. The diamond mines of Kimberly and Pretoria and the gold mines of the Rand are described in some detail. The last chapter of the book treats the correlation of the pre-Dwyka formations, which are mostly non-fossiliferous, so that the occurrences in widely separated areas are of difficult identification. An excellent list of papers on South African geology and an index close the volume.

W. M. D.

'Gli Insetti, loro organizzazione, sviluppo, abitudini e rapporti coll'uomo. By Professor ANTONIO BERLESE, director of the Royal Station for Agricultural Entomology in Florence. Milan, Societá Editrice Libraria. 1906. Published in parts at one lira each.

With such excellent recent general American books on insects as those of Kellogg and Folsom, it would seem difficult for a book in a foreign language to meet any great demand in this country, yet the admirable work of Professor Berlese, of which seventeen parts have already been published, will undoubtedly prove a very important addition to the libraries of all institutions in which advanced morphology is being studied and in all laboratories in which the study of insects is undertaken from any point of view.

Berlese is a master, a man of broad ideas, thorough training, admirable in technique, clear in demonstration, an excellent writer, and a capable draftsman. His work when completed will be both sound and comprehensive. It will comprise two volumes, of which the first will in a general way contain the anatomy and the second the biology of insects. The first volume will consist of from seven to eight hundred pages and will be accompanied by about one thousand figures. Of these, 550 pages have been published in seventeen parts, and the printed parts contain six hundred figures and four plates.

The subjects considered in the first volume, by chapters, are:

I. Brief History of Entomology.
II. Size of Insects.
III. Plan of the Insect Structure.
IV. Embryology in General.
V. Morphology in General.
VI. Exoskeleton.
VII. Endoskeleton.
VIII. Muscular System.
IX. Integument and its Structure.
X. Glands.

There still remain to be published chapters on the nervous system and organs of sense, organs of digestion, organs of circulation, organs of respiration, organs of secretion, and sexual organs. In the part already completed the chapters on morphology are marvels of detail and thoroughness. The work itself is a large octavo, and more than ninety pages are devoted, for example, to the study of the exoskeleton of the head, while nearly eighty pages are occupied with the treatment of the muscular system. Nearly all of the numerous and strikingly apt illustrations are original, having been drawn by Dr. Berlese himself. Each section of the work is followed by a very complete bibliography, and the author has shown a perfect knowledge of the work of other men, the publications of American authors having been considered and studied with a thoroughness quite unusual among European authors.

The second volume, which has been reserved for the treatment of biology of insects, will contain a careful consideration of all questions of economic importance, and it will undoubtedly be of interest to learn from this work Berlese's final views on the subject of parasitism, and especially the relations of insects and birds upon which point he has long been at odds with other Italian zoologists.

L. O. Howard.

SCIENTIFIC JOURNALS AND ARTICLES.

The October number (volume 7, number 4) of the *Transactions of the American Mathematical Society* contains the following papers:

O. Bolza: 'Weierstrass's theorem and Kneser's theorem on transversals for the most general case of an extremum of a simple definite integral.'

J. Pierpont: 'Area of curved surfaces.'

W. A. Manning: 'On multiple transitive groups.'

L. Stickelberger: 'Zur Theorie der vollstandig reduciblen Gruppen, die zu einer Gruppe linearer homogener Substitutionen gehören.'

L. E. Dickson: 'On commutative linear algebras in which division is always uniquely possible.'

H. F. Blichfeldt: 'On the order of linear homogeneous groups.'

J. I. Hutchinson: 'On automorphic groups whose coefficients are integers in a quadratic field.'

F. R. Moulton: 'A class of periodic solutions of the problem of three bodies with application to the lunar theory.'

J. H. McDonald: 'A problem in the reduction of hyperelliptic integrals.'

C. N. Haskins: 'On the differential invariants of a plane.'

This number contains also: Notes and Errata, volumes 6, 7; Table of Contents, volume 7.

The November number (volume 13, number 2) of the *Bulletin of the American Mathematical Society* contains: Report of the Thirteenth Summer Meeting of the American Mathematical Society, by F. N. Cole; Report of the New Haven Colloquium, by Virgil Snyder; 'Theory and Construction of Tables for the Rapid Determination of the Prime Factors of a Number,' by Ernest Lebon (translated by W. B. Fite); 'On a Fundamental Relation in Abstract Geometry,' by A. R. Schweitzer; 'On the Orderly Listing of Substitutions,' by D. Lehman; 'The Boston Colloquium' (Review of Lectures on Mathematics by E. B. Van Vleck, H. S. White, F. S. Woods) by J. I. Hutchinson; Correction; Notes; New Publications.

SOCIETIES AND ACADEMIES.

NATIONAL ACADEMY OF SCIENCES.

The autumn meeting of the academy was held on Tuesday, Wednesday and Thursday, November 20, 21 and 22, in the new buildings of the Harvard Medical School, Boston. The list of scientific papers was much longer than it has been at any session of the academy in recent years. It was, indeed, necessary to read by title many of the papers, which according to the program were as follows:

Alexander Graham Bell: 'A few Notes Concerning Progress in Experiments relating to Aerodromics.'

William Edward Story, Clark University (introduced by A. G. Webster): 'A Method for the Enumeration of Algebraic Invariants.'

Arthur Gordon Webster, Clark University: 'Acoustic Measurements.'

W. T. Porter, Harvard Medical School (intro-

duced by H. P. Bowditch): 'Vasomotor Relations.'

ARTHUR A. NOYES and others, Massachusetts Institute of Technology: 'The Conductivity, Ionization, and Hydrolysis of Salts in Aqueous Solution at High Temperatures.'

R. S. WOODWARD, Carnegie Institution, Washington: 'Theory and Application of the Double Suspension Pendulum.'

RUSSELL H. CHITTENDEN, Yale University: 'The Minimal Proteid Requirement of High Proteid Animals.'

GILBERT N. LEWIS, Massachusetts Institute of Technology (introduced by A. A. Noyes): 'The Free Energy of Oxidation Processes.'

GEORGE W. PIERCE, Harvard University (introduced by John Trowbridge): 'Wave-length Measurements in Wireless Telegraphy.'

EDWIN H. HALL, Harvard University (introduced by John Trowbridge): 'Measurement of the Thomson Thermoelectric Effect in Metals.'

JOHN TROWBRIDGE, Harvard University: 'Analogy between Electrical Energy and Nervous Energy.'

JOSEPH BARRELL, Yale University (introduced by W. M. Davis): 'Continental Sedimentation with Applications to Geological Climates and Geography.'

THEODORE LYMAN, Harvard University (introduced by John Trowbridge): 'Light of Extremely Short Wave-length.'

W. M. DAVIS, Harvard University: 'The Eastern Slope of the Mexican Plateau.'

ELLSWORTH HUNTINGTON, Harvard University (introduced by W. M. Davis): 'Evidence of Desiccation during Historic Times discovered in Chinese Turkestan in 1905–06.'

WILLIAM H. PICKERING, Harvard University (introduced by E. C. Pickering): 'Planetary Inversion and the tenth Satellite of Saturn.'

S. I. BAILEY, Harvard University (introduced by E. C. Pickering): 'The Work of the Bruce Telescope.'

THEODORE W. RICHARDS, L. J. HENDERSON and H. L. FEVERT, Harvard University: 'The Heat of Combustion of Benzol.'

THEODORE W. RICHARDS and GEORGE S. FORBES, Harvard University: 'The Atomic Weights of Nitrogen and Silver.'

ROBERT T. JACKSON, Harvard University (introduced by E. L. Mark): 'Structure of Richthofenia.'

W. E. CASTLE, Harvard University (introduced by E. L. Mark): 'On the Process of Fixing Characters in Animal Breeding.'

E. L. MARK and J. A. LONG, Harvard University: 'The Maturation of the Mammalian Ovum.'

E. L. MARK, Harvard University: 'The Marine Biological Station at La Jolla, Cal.'

G. H. PARKER, Harvard University (introduced by E. L. Mark): 'Reactions of Amphioxus to Light.'

H. C. JONES, John Hopkins University (introduced by Ira Remsen): 'The Absorption Spectra of Solutions in Relation to the Present Hydrate Theory.'

S. F. ACREE, Johns Hopkins University (introduced by Ira Remsen): 'On the Salts of Tautomeric Compounds.'

CHARLES P. BOWDITCH, Peabody Museum (introduced by F. W. Putnam): 'The Temples of the Cross, of the Foliated Cross, and of the Sun, at Palenque, Mexico.'

GEORGE C. COMSTOCK, University of Wisconsin: 'Extent and Structure of the Stellar System.'

HENRY F. OSBORN, Columbia University: 'Tyrannosaurus: Upper Cretaceous Carnivorous Dinosaur.'

HENRY F. OSBORN, Columbia University: 'Section of American Tertiaries.'

HENRY F. OSBORN, Columbia University: 'Complete Mounted Skeleton of Fin-back Lizard Neosaurus of the Peruvian.'

OTTO FOLIN, McLean Hospital (introduced by H. P. Bowditch): 'Metabolism of Creatin and Creatinin.'

CHARLES S. MINOT, Harvard Medical School: 'Nature and Cause of Old Age.'

C. S. PEIRCE, Milford P. O., Pa.: 'Phaneroscopy, or Natural History of Signs, Relations, Categories, etc.' A method of investigating this subject expounded and illustrated.

BAILEY WILLIS, U. S. Geological Survey (introduced by Charles D. Walcott): 'Heterogeneous Elements of the Continent as Factors in the History of North America.'

S. C. CHANDLER: 'Present State of Knowledge as to Motions of the Terrestrial Pole.'

CHARLES R. VAN HISE, University of Wisconsin: 'The Origin of the Ores of the Cobalt-silver district of Ontario.'

CHARLES D. WALCOTT, U. S. Geological Survey: 'Geological and Biological Study of the Cambrian Brachiopods.'

J. M. CRAFTS, Boston: 'The Catalysis of Sulphuric Acids.'

W. B. SCOTT, Professor of Geology, Princeton: 'The Miocene Mammals of Patagonia.'

GEORGE E. HALE, Director of the Solar Observatory of the Carnegie Institution: 'Sun-spot

Spectra, and their Bearing on Stellar Evolution.'

For the first time a conversazione was held in connection with the meeting. The exhibits, according to the program, were as follows:

Arthur A. Noyes, professor of theoretical chemistry, Massachusetts Institute of Technology: Platinum lined bomb with insulated electrodes for electrical conductivity measurements with solutions at high temperatures and pressures.

Theodore W. Richards, professor of chemistry, Harvard University: Apparatus used in the precise determination of chemical and physicochemical constants including the nephelometer, the adiabatic calorimeter, the device for excluding moisture from fused salts, and other apparatus.

J. B. Woodworth, assistant professor of geology, Harvard University (introduced by W. M. Davis): Fossil foot-prints, including those of amphibians, from the Carboniferous shales of Plainville (Wrentham), Mass.

W. M. Davis, professor of geology, Harvard University: Diagrams illustrating a method of reconstructing the original course of a river, now flowing in an incised meandering valley.

Joseph Barrell, assistant professor of geology, Yale University (introduced by W. M. Davis): Continental deposits of fluvial origin as indicators of geography and climate. Subaerial conglomerates, standstones and shales: (1) From the Mauch Chunk Shale (Sub-carboniferous) of eastern Pennsylvania; (2) from the lower Coal Measures (Carboniferous) of eastern Pennsylvania; (3) from the Newark Shale (Triassic) of Connecticut and New Jersey.

B. K. Emerson, professor of geology, Amherst College (introduced by W. M. Davis): A new geological map of Massachusetts.

W. North Rice, professor of geology, Wesleyan University: Superintendent Connecticut Geological and Natural History Survey (introduced by W. M. Davis): Geological map of Connecticut, on scale of four miles to the inch, by H. E. Cryary and H. H. Robinson, to be published by the State Geological and Natural History Survey.

T. A. Jaggar, Jr., head of the department of geology, Massachusetts Institute of Technology (introduced by W. M. Davis): Apparatus and product of experiments illustrating the mechanism of rill erosion. Diagrams, photographs, and apparatus.

Henry F. Osborn: (1) Recent restorations of extinct horses of North America, executed by Charles R. Knight, under direction of Henry F. Osborn, (*A*) water-colors, (*B*) photographs; (2) first complete section of the American Tertiaries,—a preliminary study.

R. DeC. Ward, assistant professor of climatology, Harvard University (introduced by W. M. Davis): Some new curves illustrating types of temperature, rainfall and cloudiness in the torrid and the temperate zones. These curves show the variations in the different elements month by month throughout the year.

Charles P. Bowditch, member of faculty of the Peabody Museum (introduced by F. W. Putnam): The temples of the cross, of the foliated cross, and the sun, at Palenque. Maudslay's plates of Palenque.

Ellsworth Huntington, holder of Hooper Fellowship, Harvard University (introduced by W. M. Davis): Buddhist manuscripts, records and letters inscribed on wooden tablets in the Kharoothi language, small plaster figures from a Buddhist lamasery, cord shoes, small plates of leather armor, etc., dating from about the third or fourth century A.D., and collected by the exhibitor in 1905 from the sand-buried ruins in the Taklamakan desert in western China.

F. W. Putnam, curator of the Peabody Museum of Harvard University: Copies of mural paintings from the temple of the tigers, Chicken Itza, Yucatan. Copied by Miss Adela C. Breton.

E. C. Pickering, professor of astronomy, Harvard University—Harvard College Observatory: Recent work of the Harvard College Observatory; illustrated by diagrams, etc. Discovery of variable stars and satellites; methods and results. Studies in stellar spectra and in lunar detail; Peruvian meteorology; diurnal variations at different altitudes.

C. S. Sargent, Arnold Arboretum, Boston: Silvicultural exhibit.

A. F. Blakeslee, Harvard Botanical Museum, instructor in botany (introduced by W. G. Farlow): Earliest states of sexuality in plants, illustrated by cultures of fungi.

M. A. Chrysler, instructor in botany, Harvard University (introduced by G. L. Goodale): Cambium in the monocotyledons.

Charles S. Minot, professor of comparative anatomy, Harvard University: Evolution of the automatic microtome; Harvard embryological methods.

Harold C. Ernst, professor of bacteriology, Harvard University (introduced by W. T. Councilman): Ultra-violet photomicrography and methods of use.

J. H. Wright, director of clinico-pathological

laboratory, Massachusetts General Hospital (introduced by W. T. Councilman): Demonstration of the histogenesis of the blood plates.

F. B. MALLORY, associate professor of pathology, Harvard University (introduced by W. T. Councilman): Demonstration of intracellular substances, and differential methods of staining.

E. E. SOUTHARD, assistant professor of neuropathology, Harvard University (introduced by W. T. Councilman): Demonstration of nerve cells and neuroglia.

S. B. WOLBACH, instructor in pathology, Harvard University (introduced by W. T. Councilman): Demonstration of two pathogenic fungi related to genus *Oidium* exhibiting changes in morphology and protective phenomena when inoculated into animals.

W. T. PORTER, professor of comparative physiology, Harvard Medical School (introduced by H. P. Bowditch): Improved kymographions.

M. L. FERNALD, assistant professor of botany, Harvard University (introduced by G. L. Goodale): Certain plants in eastern Canada.

E. C. JEFFREY, assistant professor of vegetable histology, Harvard University (introduced by G. L. Goodale): Photographic and photomicrographic illustrations of Cretaceous plants.

OAKES AMES, assistant director of the botanic garden, Cambridge (introduced by G. L. Goodale): New orchids from the Philippines.

G. L. GOODALE, professor of botany, Harvard University: A new form of 'container' for museums of botany, plaster-plaques for museums, selections from recent photomicrographs of fibers.

E. E. TYZZER, director of cancer research laboratory, Harvard University (introduced by W. T. Councilman): Photomicrographs illustrating the dermatitis produced by the Brown Tail moth.

W. B. CANNON, professor of physiology, Harvard University (introduced by H. P. Bowditch): Movements of the stomach and intestine as seen in the zoetrope.

ARTHUR GORDON WEBSTER, professor of physics, Clark University: A set of instruments for the performances of quantitative researches in acoustics.

J. C. BRANNER, professor of geology, Stanford University: Album of photographs relating to the geology of the California earthquake of April 18, 1906.

THEODORE LYMAN, instructor in physics, Harvard University (introduced by John Trowbridge): Photographs of short wave-lengths.

GEORGE C. COMSTOCK, director of the Washburn Observatory: Pendulum apparatus for the determination of the force of gravity.

W. B. SCOTT, professor of geology, Princeton University: Drawings and plates of fossil mammals, etc., for the reports of the Princeton University expeditions to Patagonia. Also published parts of reports.

BAILEY WILLIS, Geologist, U. S. Geological Survey (introduced by Chas. D. Walcott): Geological map of North America, prepared for the International Geological Congress at the City of Mexico.

CHARLES S. MENDENHALL, professor of physics, University of Wisconsin (introduced by George C. Comstock): New apparatus for pendulum determinations of gravity.

LOUIS KAHLENBERG, professor of chemistry, University of Wisconsin (introduced by Charles R. Van Hise): Apparatus for the investigation of osmotic pressures.

CHARLES F. BURGESS, professor of applied electro-chemistry, University of Wisconsin (introduced by George C. Comstock): Exhibits in applied electro-chemistry.

E. L. MARK, Hersey professor of anatomy, Harvard University: A machine for cutting wax reconstruction plates by means of an electrical device; a paraffine bath heated by electricity.

G. H. PARKER, professor of zoology, Harvard University (introduced by E. L. Mark): *Mistichthys luzonensis*, the smallest vertebrate.

W. E. CASTLE, assistant professor of zoology, Harvard University (introduced by E. L. Mark): Wild and tame guinea-pigs and hybrids between the two.

ROBERT T. JACKSON, assistant professor of paleontology, Harvard University (introduced by E. L. Mark): Binocular preparative microscope.

J. E. WOLFF, and C. PALACHE, professor, Harvard University (introduced by W. M. Davis): Examples of recent instruments, models, etc., for the study and exposition of mineralogy, petrography, and optical mineralogy.

A. G. WEBSTER, Clark University, Worcester: Dynamical tops.

GEORGE E. HALE, director of the solar observatory of the Carnegie Institution: Photographs and drawings from the solar observatory.

C. BARUS, Brown University, Providence: Charts of the distribution of atmospheric nucleation in the lapse of time.

From four to five o'clock an exhibit of lantern slides was made in the lecture room on the first floor, by Professors S. I. Bailey,

E. C. Jeffrey, A. G. Webster, Harold Ernst and E. E. Southard.

NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

THE next annual meeting of the New York State Science Teachers' Association will be held at Teachers College, Columbia University, New York City, December 26 and 27.

The program is as follows:

WEDNESDAY AFTERNOON.

DEAN JAMES E. RUSSELL, address of welcome.

DR. KELLY, Ethical Culture School: 'Are High School Courses in Science adapted to the Needs of Adolescents.'

J. M. JAMESON, Pratt Institute, Brooklyn: 'More Interesting Mechanics.'

PROFESSOR MINCHEN, University of Rochester: demonstration, 'The Principle of Interference and its Applications.'

HENRY R. LINVILLE, De Witt Clinton High School, New York City: 'Biology as Method and as Science in Secondary Schools.'

DR. GRACE E. COOLEY, Newark High School: 'The High School Biologist and the Citizen of Tomorrow.'

JENNIE T. MARTIN, Central High School, Buffalo: 'Field Work in Physical Geography.'

W. H. PLATZER, High School, Poughkeepsie: 'The Value of the Inductive Study of Relief Forms in Field Work.'

PROFESSOR GALE, University of Rochester: 'The Place of Transformation Theory in Geometry.'

PROFESSOR KEYSER, Columbia University: 'Concerning the Introduction of Modern Notions into the Geometry of Secondary Mathematics.'

WEDNESDAY EVENING.

PROFESSOR D. E. SMITH, Teachers College, Columbia University: 'The Preparation of the Teacher of Mathematics in Secondary Schools.'

PROFESSOR E. L. THORNDIKE, Teachers College, Columbia University: 'Science Teaching seen from the Outside.'

THURSDAY FORENOON.

PROFESSOR MANN, Chicago University: 'The New Move for the Reform of Physics Teaching in Germany, France and America.'

PROFESSOR SHERMAN DAVIS, Indiana University: 'Purpose of Science in the Culture of the Adolescent.'

W. M. BENNETT, West High School, Rochester: 'Some Demonstrations in Refraction and Dispersion of Light.'

J. Y. BERGEN, Cambridge, Mass.: 'Plant Physiology in Secondary Schools.'

PROFESSOR BIGELOW, Teachers College, Columbia University: 'Some Established Principles of Nature Study.'

LESTER B. GARY, High School, Buffalo; GEORGE T. HARGITT, High School, Syracuse, and JAMES T. PEABODY, Morris High School, New York City: 'The Teaching of Biological Science in some of the High Schools in New York State.'

PROFESSOR RICHARDSON, Syracuse University: 'The Study of Minerals and Rocks in Physical Geography in the High School.'

DR. JOHN M. CLARKE, State Geologist, 'Barachois, Bar and Tickle.'

A. W. FARNHAM, Oswego Normal School: 'The Relation which School Gardens may bear to Industrial and Commercial Geography.'

W. T. MORREY, Morris High School, New York City: 'Use of Reference Books in Physical Geography by Pupils in the High School.'

PROFESSOR HAWKES, Yale University: 'Secondary Mathematics from a College Standpoint.'

C. E. BIKLÉ, Horace Mann High School: 'What Equipment does a High School need for the Effective Teaching of Mathematics.'

PROFESSOR WEBB, Stevens Institute: 'The Relation between High School and College Mathematics.'

THURSDAY AFTERNOON.

PROFESSOR HALLOCK, Columbia University, demonstration: 'Optical Oddities.'

FRED Z. LEWIS, Boys' High School, Brooklyn, demonstration: 'Photomicrographs.'

PROFESSOR DAVIS, Harvard: 'Laboratory Exercises in Physical Geography,' illustrated.

W. BETZ, East High School, Rochester: 'Open Questions in the Teaching of Elementary Geometry.'

The President of the Association of Teachers of Mathematics in the Middle States and Maryland: 'The Necessity of Closer Affiliation of Mathematical Associations.'

DR. E. O. HOVEY, American Museum of Natural History: 'West Indian Volcanoes and their Recent Eruptions,' illustrated.

THURSDAY EVENING.

Lecture by Professor C. M. Woodward, and reception by the trustees of Columbia University.

TEACHERS COLLEGE, COLUMBIA UNIVERSITY,
JOHN F. WOODHULL.
NEW YORK CITY.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

AT a meeting on Monday, October 8, the following papers were read:

Notes on the Microscopic Examination of the Opaque Constituents of Ore Bodies: Dr. WILLIAM CAMPBELL. (Illustrated with lantern slides.)

The first part of the paper dealt with the preparation of the specimen for examination; of the various types of microscopes used; and the means of obtaining illumination by reflected light. Next the paragenesis of the constituents of certain alloys was shown by microphotographs. Lastly the methods were applied to the opaque constituents of ores from Butte; the cochise district of Arizona; Ducktown, Tenn.; Rossland, B. C.; Sudbury, Ont.; southeast Missouri, etc.

Notes on the Preglacial Channels of the Lower Hudson Valley as revealed by Recent Borings: Dr. C. P. BERKEY.

Borings made by the Board of Water Supply of New York City, in connection with the project of bringing water from the Catskill Mountains, have shown the existence of numerous deeply buried channels representing preglacial stream courses. Many of them indicate channels cut far below present sea level at considerable distances back from the Hudson River. From engineering records it appears that the depth to bed-rock in the Hudson River has never been determined at any point in its lower course. Profiles of supposed rock-bottom based upon wash-borings have been proven by the recent work to represent simply the bottom of the finer silt filling. The results show that more than 200 feet of more compact material lies below this silt at the point now being tested, and that the rock bottom of the ancient Hudson lies more than 450 feet below the present river level throughout a large part of its lower course.

Notes on the Character and Origin of the Pottsville Formation of the Appalachian Region: Dr. A. W. GRABAU.

The character of the overlap of the several divisions of the Pottsville, and the material and type of cross-bedding were discussed and the conclusion reached that the formation is of the nature of an alluvial cone—or several confluent ones, with occasional marine intercalations.

Professor D. S. Martin exhibited a large crystal of pink beryl, which he had lately obtained at Haddam Neck, Conn. The old quarry in the albite pegmatite at this locality, long famous for its colored tourmalines, is not now being worked; but a new one has been opened closely adjacent, and apparently on a continuation of the same vein or dike. This one has yielded less tourmaline than the former, but much more beryl, and particularly the heretofore very rare pink variety. Of these, a number of fine large crystals have been obtained, comparable with those lately developed from the gem-tourmaline mines in San Diego County, California.

The present specimen measures about four inches in both length and diameter; it is a fine termination, of the type characteristic of this variety. It has been recently shown by Ford (*Am. J. Sci.*, Sept., 1906) that these pink beryls, from whatever locality, present a peculiar type of crystallization. Instead of the long hexagonal prism with flat basal termination, usually seen in the green beryls of New England, the pink ones tend to a strong development of pyramidal planes, especially the pyramid of the second order (*s*), while the prismatic faces are short. It is very interesting to see how perfectly this crystal, from a new locality, conforms to this statement. It shows three very short and partly broken prismatic faces, and a large and perfect hexagonal pyramid of the second order; the basal plane is reduced to a small irregular face about one inch in its longest diameter, and bears several shallow pits or depressions, of which the inclined sides conform to the pyramid of the first order. Altogether, the specimen is one of unusual interest.

A. W. GRABAU, *Secretary.*

THE AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION.

THE first regular meeting of this section was held on November 9 at the Chemists' Club, 108 W. 55th Street.

Professor A. A. Breneman, chairman of the section, presented his opening address, which was, in the main, an account of the history of organization among chemists in America, with remarks upon the present status of chemistry as a profession. He described the origin of the American Chemical Society and the Chemists' Club and urged the importance of maintaining a high standard of education among chemists.

Professor Winslow, of the biological department of the Massachusetts Institute of Technology, spoke 'On the Disposal of City Sewage.' Professor Winslow presented the prominent features of the development of sewage treatment in a clear and comprehensible manner, showing numerous slides to illustrate the various types of sewage plants. He indicated the research work now in progress at the Massachusetts Institute of Technology sewage experiment station and finally spoke of the latest developments in the purification of sewage, noting especially the trickling system.

The subject was supplemented by remarks from Professor Pellew on an interesting sewage problem in White Plains and by Dr. Soper, who spoke of the coming need of purifying sewage before dumping it into New York Bay.

C. M. Joyce,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PRINCIPLES WHICH GOVERN THE UNITED STATES GEOLOGICAL SURVEY IN ITS RELATIONS WITH OTHER GEOLOGICAL SURVEYS AND WORKING GEOLOGISTS.

To the Editor of Science: Certain questions raised by the correspondence published by Professor Branner in Science for October 26 are, as he says, of general interest; and, in view of the manner in which they are there presented, require a statement of the principles which govern the United States Geological Survey in its relations with other geological surveys and working geologists.

There is among scientists in general a rule of courtesy that denies to others the privilege of investigation in a direction which one has made his own by reason of his contributions to knowledge along that line. The rule is variously construed in different countries and by different men, but it is no part of my purpose to minimize its force. It has been recognized by the national survey since the days of Director King, and is now effective in relations with individuals and state surveys. It is, however, necessarily controlled by the progress of the general survey and the development of general plans, which sometimes require that work shall be done by the national organization notwithstanding meritorious individual claims. Moreover, professional courtesy on the part of a public official is subject to limitations imposed by his obligation to Congress and to the people to render prompt and efficient service.

A long experience, including relations with nearly all the working geologists of the country, has clearly demonstrated that men whose first obligation is to a university can not work as efficiently for the national survey as can the geologists constantly in its employ, and recognition of this fact has led in recent years to a reduction of the proportional amount of work allotted to teachers of geology, who can give but a share of their time to it.

These considerations governed the national survey in the matter of the Arkansas coal fields. Not only professional courtesy but also personal regard prompted the offer of cooperation made to Dr. Branner under date of January 31, 1906, the purpose of which was to secure to him the publication of his results and the credit due him for his service to the state, as well as to avoid unnecessary duplication of field work. The obligation to execute the surveys with that promptness and efficiency which could follow only from undivided attention required that his desire to finish the work should be disregarded.

It appears from Dr. Branner's latest letter that he still regards the survey of a coal field worth many millions of dollars and capable of serving several millions of people as his personal affair. This bureau is directed on broader lines. He is led by his personal view of the question to misconstrue not only the correspondence which has passed, but also the administrative policy of the national sur-

vey. The insinuation that the proposal to pay for the Arkansas reports could have had an improper motive may be set aside as unworthy of his own standing and mine. But I deny his charge that the survey is an undemocratic organization which abuses its power to the disadvantage of state surveys or of individual geologists. It encourages the organization of state surveys and seeks to cooperate with them in all practicable ways. It endeavors to maintain cordial cooperative relations with all working and teaching geologists, and welcomes all practical suggestions which may lead to a closer touch with them. That its attitude in these relations is necessarily controlled by the obligations of a national bureau to the people has already been said.

The last quarter of a century has been one of extraordinary development in geology. The leaders in this progress have been members of the United States Survey, and by virtue of their services it has had a dominant influence in the development of methods and of knowledge. To serve on its staff, in whatever capacity he is qualified by experience to fill, is no discredit to any geologist, nor is it a reflection on any geologist, however able and honored, that the work which he did a decade or two ago should require revision and should be revised according to the latest standards of topographic and geologic skill by the specially trained members of the national survey's permanent staff.

CHARLES D. WALCOTT.

A NEW VARIETY OF HONORARY PH.D.

WHAT constitutes an acceptable thesis for a Ph.D. degree is a problem which at some time has engaged the attention probably of every department and surely of every graduate faculty in our real universities. Of course it matters little to those institutions which still continue, in defiance of the best opinion and practise both here and abroad to grant the degree *honoris causa* or as a reward for the completion of a set time or of a specific series of courses. But it was a matter of astonishment to learn that graduate schools with higher ideals are given to accepting as theses publications which have no evident relation to themselves, if indeed these papers reflect in any way the influence of the degree-granting institution. Within the past two years and at two different universities of good standing in the country, I have asked by chance what the work of a newly introduced doctor had been and was shown in each case a voluminous government document. Careful examination not only demonstrated that the publication was everywhere attributed to the direction and support of the particular division, the name of which appeared prominently printed on the cover and title pages, but also failed to disclose anywhere in the text the most obscure reference to the institution which had crowned the writer with the coveted laurel. Perhaps it is wrong to question the procedure, but the student had not been actually in residence for more than a brief period 'because you know,' the professor in charge naïvely remarked, 'he could not find the material or the literature for that work here, and then, too, the bureau paid all the expenses of the work.' One could not help wondering what part in the work the aforesaid professor had played when he had evidently not even assigned the topic for investigation.

But the climax appeared in a communication which one of my own colleagues received the other day. A long-time student and good friend of his had left his work for the doctorate partly finished to take a government position in the national capital, and after some time there wrote regarding his still unfinished thesis, "Unless some arrangements can be made by which the university will accept, as has been done in recent instances, and as is done by other universities, an official publication as fulfilling the thesis requirements, I shall have to abandon the plan of taking my degree from ——————————— and try another institution." The cordial relations existing between the two parties preclude any thought that an intellectual hold-up was attempted; it was merely the frank statement of the facts as the younger man in his official intercourse had found them. If the plan is recognized as feasible in official circles, as this and other circumstantial evidence would

serve to show is the case, then what of it from the university standpoint? No one would question that many government publications are abundantly worthy of the honor, but consider first the usually composite authorship which makes it exceedingly difficult to attribute to any single individual his due share of the work or to stamp it in any sense as research on his part; add to this the full financial and legal responsibility of the particular government bureau for the character and scope of this piece of investigation. Consider further the absolute lack of control on the part of the university over the correctness of the results reached, together with the omission of even its name from the text of the paper, and it is hard to say wherein this procedure differs from granting the degree purely *honoris causa*. After all, there are many men in actual work to-day who achieve results which *per se* would warrant granting them a doctorate. The best elements in university circles unite in agreeing that such a practise is dangerous, subversive of the best interests of graduate work and tending to break down the real university which we are now striving to build up in this country. This new tendency is equally disastrous and if seen in its true light is only another form of the ancient error against which university men should be on their guard. X.

AN INTERMITTENT FLOWING WELL.

Some months ago the city of Albany, Georgia, in order to get rid of an objectionable pond of water in the suburbs, attempted to drain it off underground by boring a well to a cavernous limestone, ninety or one hundred feet below the surface, when this rather singular phenomenon was discovered. Mr. Charles Tift, former city engineer, and a very accurate observer, gives the following description of the well:

A low place in the city requiring drainage and there being no natural outlet, it was decided to bore an eight-inch well to the cavernous limestone, by which method other ponds in the city had been drained. This special pond covered an area of about one half of an acre, the water having an average depth of eighteen inches. The well was bored at the edge of the pond, a small dam having been previously made to keep back the water. At the depth of ninety feet, the drill dropped some six or eight feet into a cavity. The drill was then withdrawn and the dam removed. The water at once began to run very rapidly into the well, not completely filling the bore hole, however. In six and one half minutes the well filled and the water began to bubble and almost immediately thereafter the entire column of water was ejected with considerable violence to an estimated height of about thirty feet. When the ejecting force spent itself, the water again commenced to flow into the well, and the same phenomenon was again repeated.

For about an hour the ejections continued, but with gradually decreasing violence and at longer intervals, but ceased entirely only when the static head of the water in the pond became greatly reduced. This well is said to repeat its geyser-like action whenever a heavy rainfall fills the pond.

S. W. McCallie.
Georgia School of Technology, Atlanta.

'THE WIRELESS TELEGRAPH AND AURORA.'

Some time ago I conceived the idea that the wireless telegraph might give assistance in unravelling the mystery of the aurora. The result was not exactly what I expected, and at the present time seems to add more complication to what was already complicated.

I have a record of observation by the wire on six nights during the last year, grouped in three, one and two, respectively, giving what are known as 'freak distances,' during spells of aurora, or the brilliant clear weather associated with aurora. During these three periods we received signals and read messages over abnormal ranges of 700 to 1,600 miles with an apparatus that ordinarily will not operate over more than 250 miles.

The apparatus could receive, but not send, and directly the aurora ceased or diminished, in at least four cases, the long distance messages also ceased to reach our wire.

My facilities are woefully inadequate, and I hope some weather service station with

wireless equipment, or one of the several wireless telegraph companies will take the matter up; for although it may not lead to a better understanding of aurora, it might help to the understanding of 'freak distances' over the wire.

C. J. STUART.

MONTREAL, October 29, 1906.

THE GLACIAL EPOCH.

TO THE EDITOR OF SCIENCE: While I much regret having overlooked the references to which Professor Chamberlin calls attention in the first few lines of his communication to SCIENCE (October 26, page 531), his further remarks (tending to demonstrate that Dr. Manson's theory is untenable), when considered in connection with the equally modern and equally reliable views of Professor E. W. Hilgard (as expressed in the last paragraph of his paper quoted on page 440 of this journal) afford an instructive illustration of how difficult it is, even for an able and conscientious investigator, to avoid dogmatism in science.

J. M. SCHAEBERLE.

ANN ARBOR,
October 29, 1906.

SPECIAL ARTICLES.

VARIATION IN PARTHENOGENETIC INSECTS.

IF, as the Neo-Darwinians claim, amphimixis is the principal cause of variation (of the continuous or fluctuating sort taken by Darwin and Weismann to be the material used by natural selection for species-building), it would seem to follow that much less variation, of this type, should occur among parthenogenetically produced individuals than occurs among individuals of bi-sexual parentage. The Neo-Darwinians explain variation as a product of sex and sex as a product of the necessity for variation.

The variation of bisexually produced individuals is proved by limitless miscellaneous observation and the more recent better compiled and expressed work of biometricians. But data and facts concerning the variation in parthenogenetically produced individuals are not so readily accessible. In the following paragraphs will be found a summary statement of the results of certain observations made by several assistants[1] and myself, on the variation exhibited in certain series of parthenogenetically produced insect individuals.

It is obvious that a comparison of the variation in agamically produced individuals with that of those of bi-sexual parentage *in the same species* would be particularly pertinent. And this we have been able to make in the case of the honey-bee. The variation[2] of various wing characters (dimensions of wings and vein-parts, modification of venation, number of costal hooks of hind-wing, etc.) has been studied in series of drones (parthenogenetically produced individuals) from queen-laid eggs (and also in series from worker-laid (!) eggs) and in series of workers, which are of bi-sexual parentage. Among these series are some (both of drones and of workers) in which the individuals were taken directly from the brood-cells (just as they were ready to issue) and hence before their exposure to any intraspecific (individual) selection on a basis of their adult characters (among which are all wing characters), and other series made up of actively flying, *i. e.*, exposed individuals. There are also series of drones hatched from worker-laid eggs and reared in worker cells (instead of in the usual larger drone cells), the variation in these series having a special interest because of the possibility of its modification by the extrinsic factor, size of cell. In addition to the bee series the variation in wing characters in a series of parthenogenetically produced female plant-lice (Aphididæ) has been studied. The studies are all statistical and quantitative and have been compiled, tabulated and summarized according to the now fairly familiar methods of biometric variation study. In this note only the baldest statement of results can be made, and their presumable significance suggested.

Variation in drone (parthenogenetically produced) and worker honey-bees (of bi-

[1] R. G. Bell, B. E. Wiltz, A. Wellman and F. Yantis.

[2] Some of these data of variation in the honey-bee have already been published by Kellogg and Bell, 'Studies of Variation in Insects,' *Proc. Wash. Acad. Sci.*, Vol. 6, pp. 203–332, 1904.

sexual parentage).—The honey-bee, *Apis mellifica,* is an insect with complete metamorphosis. The larvæ are footless, soft-bodied, white grubs which are born from eggs laid in cells, and which live for their whole life protected and cared for in the cells, those of any one community living under identical conditions of light and temperature and presumably of food and care. Even those of different communities have practically an identical environment. The larvæ pupate in the cells and the imaginal bees issue with wings, legs and numerous other structures wholly formed and in definitive character, and not corresponding to any functional larval parts. The variations, therefore, in the wings —to select structures particularly available for quantitative comparison, and wholly foreign to the larval body as functional parts, *i. e.,* parts capable of use or subject to disuse —must be looked on as variations as strictly congenital and independent of modifying extrinsic influences (*i. e.,* without trace of modifications acquired during development due to varying environment) as it is possible to find among animals. The wings, also, are structures possessed by all the three kinds of individuals composing the honey-bee species, and in all three kinds function identically, so that any variations the wings may exhibit can not be attributed to differences in the special function of the wings in the different kinds of individuals, but may be safely associated with the other general features in the make-up of each kind of individual, and be referred to as fair indicators of the kind and extent of variation characteristics of the different kinds of individuals.

The right and left fore and hind wings (removed and mounted on glass slides) of various lots of drones and workers were examined and measured for variations in (*a*) modifications of the normal (= modal) venation, consisting of the addition of vein spurs in 'slight,' 'fair' or 'marked' condition, and interpolated new incomplete or complete cells; (*b*) dimensions, as length and breadth of the whole wing, and length of vein-parts, these parts determined by the giving off of branches in the insertion of cross-veins; and (*c*) the number of grasping hooks along the costal margin of the hind wings.

The lots studied were: (1) a lot of 300 Italian drones taken from a laboratory hive, (2) a lot of 300 workers taken from same hive, (3) a lot of 48 Italian drones from a field hive, (4) a lot of 300 workers from this hive, (5) a lot of 100 German workers from another field hive, (6) a lot of 200 Italian drones from a field hive which were taken from their brood cells when just ready to issue, (7) a lot of 54 Italian workers from the laboratory hive taken from brood cells, (8) a lot of 25 Italian workers taken from cells and 50 workers acting as nurses (not yet having ventured from the hive) from a field hive, (9) a lot of 26 Italian drones from a field hive, taken from worker cells, (10) a lot of 200 drones from a queenless field hive (these drones hatched from worker-laid eggs and reared in worker cells), and (11) a lot of 60 Italian drones from worker eggs in worker cells taken from the cells at time of emergence. The lots of individuals taken from the brood cells just when ready to emerge (in fully formed imaginal condition with all wing-parts fully developed and in fixed definitive condition) were obtained for the purpose of ascertaining what difference, if any, exists in the amount of variation (in venation of wings) between bees exposed to the struggle for existence and bees not yet so exposed. If selection is really rigorous and intra-specific, that is, if varying individuals are preserved or extinguished on a basis of rigorous selecting among these variations, then one would expect that a series of individuals of any one species examined after exposure to this rigorous individual selection would show less variation than a series of individuals of the same species not yet exposed to this personal selection. The unexposed series should reveal the total amount of the variation characteristic of the species; the exposed series should reveal the amount of variation tolerated by a rigorous intra-specific selection. Also, as the workers in their constant going and coming outside the hive, carrying heavy loads of pollen, and ex-

posed to any danger which slow or imperfect flight might induce, as capture by birds and robber flies, may be fairly said to run much more risk in their life than the drones which make but a single brief daily flight (and that not every day), it might be thought or assumed that this strenuous life of the workers would tend to weed out by life-and-death selection every slight disadvantageous variation in the supporting skeleton (the venation) of the wings, all-important organs in this outside life. The series of drones reared in worker cells were obtained for the purpose of testing the assumption of Casteel and Phillipps (*Biol. Bull.*, V., 6, pp. 18–37, 1903) that extrinsic factors, depending on the shape and size of the brood cells, are of large importance in producing the drone variation. The series of drones hatched from worker eggs were obtained for the purpose of ascertaining the differences, if any, in the amount of variation exhibited by individuals normally parthenogenetically produced (from queen-laid eggs) and those abnormally parthenogenetically produced (from worker-laid eggs).

Now, the results of all this examination, mensuration and compilation (and this work, extending over several years, has been not inconsiderable) might be presented in a detailed way by curves and mathematical expressions, with, I hope, some special interest and profit to students of bionomics (which is evolution), but for the purposes of this note the baldest and most summary statements of them must suffice. These statements are the following: (*a*) In all but one of the characteristics studied, the amount of variation, both quantitative and qualitative, is markedly larger among the drone bees than among the workers, and in the one exceptional characteristic it is no less; (*b*) no more variation in wing characters is apparent among drones or workers that have not been exposed in imaginal condition to the rigors of personal selection than exists among bees, drones or workers, that have been so exposed; (*c*) the variation in wing characters in drone bees reared in worker cells is no greater than that among individuals reared in drone cells; (*d*) the variation among drones hatched from worker-laid eggs is markedly larger than that among drones hatched from queen-laid eggs (the drones of worker parentage are considerably smaller than those of queen parentage).

The significance of these results may be suggested to be: of result *a*, that the blastogenic variation among bees does not depend on amphimixis but is a result of some other factor; of result *b*, that the assumed rigorous intra-specific selection among slight continuous variations, which is a basic assumption in the natural-selection theory of species-forming, does not appear to exist in the case of honey-bees; of result *c*, that the larger variation of drone (parthenogenetically produced) bees compared with worker bees (of bi-sexual parentage) is not an ontogenetic phenomenon due to special extrinsic factors (size of cell) operative during development; and of result *d*, that the farther we get from amphimixis the greater we find the blastogenic variation to be!

I do not mean to insist too strongly on this last conclusion! There are two possible facts which may tend to invalidate it. One is that of the abnormality of parentage; the lack of practise, as it were, of the worker parents in the complex business of reproduction; the other is that our series of drones of queen parentage reared in worker cells is unfortunately too short to safeguard properly the conclusions derived from the study of the variation in it. While, as already stated as result *c*, the variation in this series showed no signs, except perhaps in one characteristic, of being proportionally larger than among drones reared in drone cells, a larger series might have revealed this possible larger variation. But the data of this short worker-cell series are typical of short-series data generally, and the marked lessening of the range in variation shown is quite in consonance with what should be found in a normal fractional part of a large series. However, it is well to accept result *c* with some reservation and hence to carry that reservation over to result *d*, inasmuch as the drones of worker parentage were all reared in worker cells. The actual fact, however, stated in result *c* is wholly true,

namely, that the drones of worker parentage show a much larger variation than those of queen parentage. Their coefficient of variation is from 50 per cent. to 75 per cent. greater. Also if results *d* and *c* are to be accepted with reservations, then so are the interpretations of their significance.

It may be said by some that the larger variation in the drones as compared with the variation in the workers may be due to the fact (?) that 'males vary more than females.' This generalization, which is one of Darwin's variation canons, has long been disproved as a general law. It is true in certain cases or classes of cases, these being mostly those in which the males possess certain secondary sexual characters of ornament and bizarrie, such as tufts, plumes, horns, processes, etc. The variation in such characters seems to be larger than in other body parts or at least this is generally believed to be true, although I do not now recall the detailed variation studies on which this belief is based, or should be based. But the characters chosen for study in the bees are precisely such as are not secondary sexual ones or special adaptations but are characters common in structure and use to both drones and workers. In other variation studies of exactly these characters, namely, characters of wing venation, in other kinds of insects, for example, the mosquito, we have not found the males to show a larger variation than the females. In these other cases both sexes are of bi-sexual parentage.

Variation in female aphids (parthenogenetically produced).—In the following paragraphs is presented a brief statement of the variation conditions found to exist in the venation of a series of parthenogenetically produced *female* insects. Unfortunately, the variation of these parthenogenetically produced females can not be compared with that in series of bi-sexual parentage of either sex in the same species, but, thanks to the methods of the biometricians, the mathematical expression of this variation (the coefficient of variation according to Pearson's formula) allows us to compare its extent with the variation of venation characteristics in other kinds of insects, male or female, of bi-sexual parentage.

In a series of 200 winged females of the mustard plant louse (species unknown), produced viviparously by agamic stem-mothers, and collected on the university campus, the variation in wing size, in dimensions of vein-parts, in modification of the venation (addition or loss of branches and cells, etc.) in fore and hind wings, and the number of grasping hooks on the hind wings were studied. In all these characters a notable variation is apparent. In modification of venation (addition or loss of branches, change of forking, interpolated cells and the like), 76 wings out of the 800 show notable variation. No biometric expression can, of course, be given for this substantive variation. For the meristic variation, however, in number of costal hooks, in length and breadth of wings, in length of various vein-parts (varying independently of the varying size of the wings) the coefficients of variation have been determined, and are notably large. For example, they are as large as the coefficients of the variation in similar wing-parts in mosquitoes,[3] ants and worker bees, in all of which amphimixis is the rule. We have not been able to compare the variation in parthenogenetically produced aphids with that in the early spring generation of stem-mothers that comes from eggs of bi-sexual parentage. Perhaps we shall be able to do this in another year. But what we have already before our eyes is sufficient to show us that variation actually exists among these parthenogenetic individuals in extent and character sufficient to serve natural selection as a species-building basis, if the familiar fluctuating, continuous or Darwinian variation ever is sufficient for this purpose. Amphimixis is not only not necessary in order to insure Darwinian variation, but there is no evidence (that I am aware of) to show that it increases this variation. There is, on the other hand, a little evidence, some of it pre-

[3] For determinations of variation conditions in these other insects see Kellogg and Bell, 'Studies of Variation in Insects,' *Proc. Wash. Acad. Sci.*, Vol. 6, pp. 203–332, 1904.

sented herewith, to show that such variation occurs, whether the offspring be of uni-parental or bi-parental ancestry, and to show that this variation is no greater in amphimixis than among parthenogenetically produced individuals. Yet Weismann's plausible assumption will probably long continue to hold its unproved own.

VERNON L. KELLOGG.
STANFORD UNIVERSITY, CALIF.

A STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE. II.

THE MEASUREMENT OF SCIENTIFIC MERIT.

MANY of the problems that the writer had in view in the present research might be solved by the study of any group of a thousand American men of science, so long as they had been objectively selected. The objective selection of a group sufficiently large for statistical treatment is, however, essential. As cases can be quoted to illustrate the cure of nearly every disease by almost any medicine, so examples can be given in support of any psychological or sociological theory. The method of anecdote, as used by Lombroso, may be readable literature, but it is not science. A thousand names might have been selected by lot from all the scientific men of the country, assuming a list to have been available, but a group of the thousand leading men of science arranged in the order of merit has certain advantages. Information in regard to them can be better obtained than in the case of those who are more obscure. Correlations can be determined between degrees of scientific merit and various conditions. The comparison with a similar group selected ten or twenty years hence, or with a similar group of British, French or German men of science, would give interesting results. The list itself, if printed after an interval of twenty years, would be a historical document of value. Lastly, the data can be so used as to carry quantitative methods a little way into a region that has hitherto been outside the range of exact science. It is the last problem that I wish to take up in this paper.

It will be remembered that we have in each science the workers in that science arranged in the supposed order of merit by ten competent judges, who made their arrangements independently. If the ten arrangements agreed exactly, we should have complete confidence in the result, except in so far as it was affected by systematic or constant errors. If there were no agreement at all, the futility of any attempt to estimate scientific merit would be made clear. The conditions are naturally intermediate. There is a certain amount of agreement and a certain amount of difference of opinion. Thus taking, for example, the ten astronomers—I., II., III., etc.—whose average positions were the highest, the order given to them by each of the ten observers, *A*, *B*, *C*, etc., is as shown in the table:

TABLE I. THE ORDER ASSIGNED TO TEN ASTRONOMERS BY TEN OBSERVERS.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
A	1	2	4	3	10	6	9	5	11	8
B	1	4	2	5	6	?	9	3	8	7
C	1	4	?	5	2	*16	6	17	7	*21
D	?	2	4	3	1	5	7	13	8	6
E	1	*9	2	5	6	3	8	4	7	11
F	1	4	10	2	5	6	3	7	8	11
G	1	3	5	*16	2	6	7	13	4	8
H	1	3	5	7	6	4	9	?	8	2
I	1	2	8	4	10	6	7	3	11	5
J	1	2	4	5	12	8	3	6	13	7
AV.	1.0	3.5	4.8	5.5	6.0	6.6	6.8	7.8	8.5	8.6
av.	1.0	2.9	4.8	4.3	6.0	5.5	6.8	7.8	8.5	7.2
m.v.	0.0	1.4	1.9	2.4	2.8	2.3	1.7	4.3	1.9	3.4
P.E.	0.0	.45	.59	.84	.84	.85	.48	1.15	.54	1.09
p.e.	0.0	.39	.57	.68	.79	.69	.48	1.28	.54	.96

Here we find complete agreement that I. is our leading astronomer. He has been selected as such by nine competent judges from the 160 astronomers of the country.[1] The probability that this is due to chance is entirely negligible. II. stands next in scientific merit. He is placed second by four of the observers, third by two, fourth by three and ninth by one. The conditions are similar to observations in the exact sciences. The average position or grade is 3.5, and the probable error of this position is 0.45, *i. e.*, the chances are even that this grade is correct within one half of a unit. The grade of the astronomer who stands third is 4.8, and that of the astronomer who stands fourth is 5.5. There is consequently one chance in about fifty that II. deserves a grade as low as that of III., and one in about one thousand that he deserves a grade as low as that of IV. The order thus has a high degree of validity, and this has itself been measured. As we go further down the list, the probable errors tend to increase, the order is less certain, and the difference in merit between a man and his neighbor on the list is less. The variations in the sizes of the probable errors are, as a rule, significant. When the error is small the work of the man is such that it can be judged with accuracy; when it is larger it is because the work is more difficult to estimate.

The probable errors depend on the assumption that the individual deviations follow the exponential law, and they do so in sufficient measure for the purposes in view. For those near the top of the list, the distribution of errors is 'skewed' in the negative direction, that is, there are relatively more large negative than positive errors. Thus in the table there are four judgments marked with a star, the deviation of each of which is more than three times the average deviation, and these observations would be omitted by an approximate application of Chauvenet's criterion. If these four observations are omitted, the grades of the ten astronomers are those given in the second line of averages. The omitted judgments are not extremely divergent, barely exceeding the limits set by Chauvenet's criterion, and I do not regard them as invalid. Indeed, I believe that in view of the presence of systematic errors in these estimates the chance that they represent correct values is greater than that assigned by a strict application of the theory of probabilities. But the incidence of an extreme judgment might in special cases do injustice to an individual, and in the order used Chauvenet's criterion has been applied.[2] This means that a compromise has been adopted between the median and the average judgment; but the departure from the average judgment is small, affecting less than one fifth of the individuals and only to a slight degree. The average deviations and probable errors used are those found when all the judgments are included. Two probable errors are given in the table, the first obtained through the error of mean square, the second by taking it as directly proportional to the average deviation. The differences are not significant, and for work of this character I regard it as useless to calculate the probable errors by the ordinary formula. I have published elsewhere[3] a more technical discussion of the treatment of errors or deviations of this character, and may return to the subject at some subsequent time. The theory of errors commonly applied in the exact sciences is too crude for psychology, and probably for the

[1] In three cases where a question mark appears the astronomer did not give a position to himself. In one case the name was not included among the slips.

[2] Among the some 15,000 observations under consideration several variations might be expected to occur in a normal distribution as much as six times as large as the probable error, and among the 1,500 or more individuals, several might be expected to deserve positions departing considerably from those assigned. But assuming that we have 'normal errors' to deal with, there is no reason why the particular individuals on whom the divergent errors fall should receive them rather than any other individuals. Such errors should apparently be distributed among all the individuals. Similar conditions must occur in the case of errors of observation in the exact sciences, but so far as I am aware their significance has not been considered.

[3] *Am. Journ. of Psychol.*, **14**: 312–328, 1903.

sciences in which it is used. Progress here will be blocked until there are psychologists who are mathematicians or mathematicians who are psychologists.

In order to illustrate further the serial distribution and the probable errors, I have made a diagram for the fifty psychologists. The grade of each, no judgments being omitted, is shown by the vertical mark, and the length of the line indicates the probable error or range within which the chances are even that the true position falls. Thus the psychologist who stands first on the list, was, like the astronomer, given this position by the independent judgment of all. The psychologist who stands second has, as shown on the diagram, a position of 3.7 and a probable error of 0.5, *i. e.*, the position 3.7 is the most probable, but the true position is equally likely to be within the short horizontal line, between 3.2 and 4.2, or outside it. It must, however, be remembered that the chances of the true position being far outside the range of this line decrease very rapidly. Over it is roughly drawn the bell-shaped curve of the normal probability integral. The true position is along the base line covered by this curve, and the chances of its being at any given point are proportional to the ordinate or height of the curve above the base line. There is only one chance in about six that the true grade is above 2.7 or below 4.7, and only one chance in about 150 that the true grade is above 1.7 or below 5.7. It will be seen from the diagram that while the positions of the psychologists II., III. and IV. are the most probable, the relative order is not determined with certainty. On the other hand, the chances are some 10,000 to one that each of these psychologists stands below I. and above V.

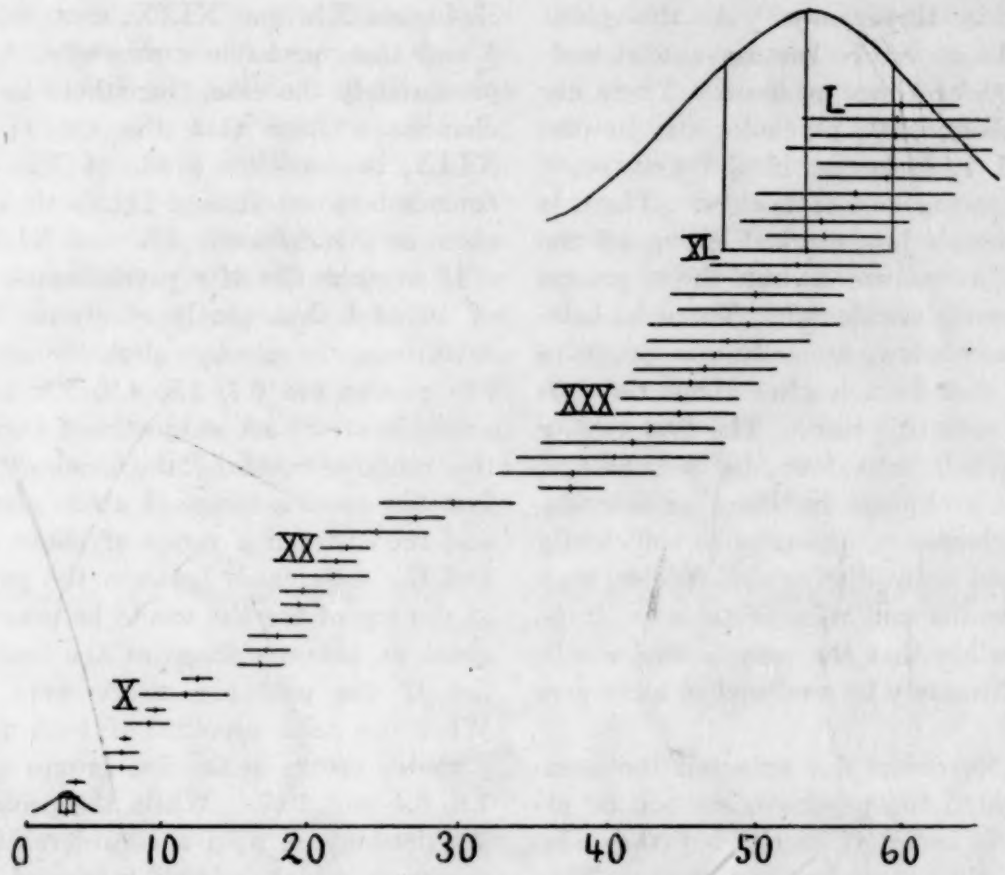

FIG. 1. The positions and probable errors of the fifty psychologists.

It is evident that the probable errors increase in size as we go down the list. The curve of distribution drawn over No. XL. indicates that the chances are even that the true

position falls between the grades of XXXIV. and L. and that there is one chance in four that he does not belong among our fifty leading psychologists. The increase in the size of the probable errors is irregular, it being more difficult to assign a position to some men than to others.

It will be noted that the psychologists fall into groups, the first twenty being set off from the next group, though the two groups are bridged over by three cases. At this point also the probable errors become almost suddenly about three times as large. There are altogether about 200 psychologists in the country, and it looks as if the first tenth forms a separate group of leaders. There is a similar, though less marked group of the first twenty astronomers, but these groups seem to be partly accidental. There is, however, as shown below, an inflection point in the curve of distribution after about the first tenth of our scientific men. The first twenty psychologists fall into four distinct groups, and there are groupings in the other sciences. They do not, however, appear to be sufficiently marked to lead us to distinguish species, such as men of genius and men of talent. It is, however, possible that the complicated conditions may ultimately be analyzed so as to give such groups.

The probable errors not only tell the accuracy with which the psychologists can be arranged in the order of merit, but they also measure the differences between them. This, indeed, I regard as the most important result of this paper, as science is advanced chiefly by the extension of quantitative methods, and it might not have been foreseen that it would be possible to measure degrees of scientific merit. Our data are concerned with the recognition of scientific performance, not with abstract ability, if such a thing is conceivable. Merit is in performance, not in non-performance, and expert judgment is the best, and in the last resort the only, criterion of performance.

The difference in scientific merit between any two of the psychologists whose positions and probable errors are shown in the chart is directly as the distance between them and inversely as their probable errors. If two of them are close together on the scale, and if the probable errors are large, the difference between them is small, and conversely.

If the psychologists II. and III. were separated by 0.5 and their probable errors were 0.5, as is approximately the case, then the difference between them is so small that there is one chance in four that the position of III. is above the grade of II. If again the psychologists XL. and XLIX. were separated by 6 and their probable errors were 6, as is approximately the case, then there is again one chance in four that the true position of XLIX. is above the grade of XL. The difference between II. and III. is thus about the same as that between XL. and XLIX.

If we take the fifty psychologists in groups of 10, and thus partly eliminate the chance variations, the average probable errors of the five groups are 0.7, 1.8, 4.2, 5.8, 6.2. These probable errors are subject to a correction for the range covered by the grades. Thus the first ten cover a range of about eleven points, and the last ten a range of about six points, and the differences between the psychologists at the top of the list would be nearly twice as great as between those at the bottom of the list if the probable errors were the same. When we take account of both factors, the probable errors in the five groups are 0.6, 1.9, 1.8, 6.4 and 10.7. While the probable errors are determined with a considerable degree of exactness, which is itself measured, the ranges covered by the grades seem to depend on the special conditions in the science; they are not the same in the different sciences, and their validity can not be determined with any exactness. Subject, however, to a considerable probable error, the range of merit covered by the fifty psychologists is inversely as the figures given, and reduced to a scale of 100 would be: 55.6, 17.5, 18.5, 5.2 and 3.2.

Thus we can say that the psychologists at the top of the list are likely to differ from each other about 18 times as much as the psychologists at the bottom of the list. We have no zero point from which we can measure psychological merit. Men who are 6 ft. 2 in. tall are likely to differ from each other

about ten times as much as men who are about 5 ft. 8 in. tall, though the difference in their height is only as 68:74. Even though we assumed the zero point to be where psychological performance begins or at the survival minimum of human ability, we should only obtain relative differences.

The astronomers and the psychologists have been used as illustrations. The number of students of astronomy and of psychology in the country does not differ greatly, and it is assumed that they represent an equal range of scientific merit. It is possible that it requires more ability to be an astronomer than to be a psychologist, and it is equally possible that, in view of the larger endowments, longer history and more conventional problems, less ability will suffice for the astronomer. The curves of distribution might also vary; for example, it might be relatively easier to be an astronomer of moderate performance, but more difficult to be a great astronomer. There are indications of such differences, but the data at hand do not disclose them with any degree of certainty.

There are 100 geologists and 100 botanists on the list, who are about one fourth of all the geologists and botanists of the country. These are assumed to cover about the same range of scientific merit as the astronomers or the psychologists. The average difference between the geologists would consequently be about half that between the astronomers, and the probable errors of position should theoretically be about twice as large. The anthropologists are the smallest class of scientific men, numbering in all about ninety, of whom 20 are included in the thousand under consideration. They are again assumed to cover a range of performance equal to that of the astronomers or geologists, the average difference between them being two and a half times as great as between the astronomers or five times as great as between the geologists. The chemists are the most numerous class of scientific men, 175 being included in the thousand. There are 150 physicists, 150 zoologists, 80 mathematicians, 60 pathologists, 40 physiologists and 25 anatomists.

In the accompanying table are given the

TABLE II. GRADES AND PROBABLE ERRORS OF THE TWENTY MEN OF SCIENCE WHO STAND FIRST IN EACH OF THE SCIENCES.

	Mathematics.		Physics.		Chemistry.		Astronomy.		Geology.		Botany.		Zoology.		Physiology.		Anatomy.		Pathology.		Anthropology.		Psychology.	
	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.	Av.	P.E.
I.	2.5	.6	1.6	.7	3.6	.6	1.0	0	2.5	.4	2.9	.8	2.7	.2	2.0	.3	1.5	.3	1.0	0	1.7	.2	1.0	0
II.	3.3	3.0	3.2	2.5	4.4	.5	*2.9	.4	3.3	.4	3.3	.5	3.2	1.0	2.6	.3	*1.8	.2	3.9	.3	2.6	.2	3.0	.5
III.	3.7	.7	8.7	2.7	5.5	1.7	*4.3	.6	5.4	1.6	5 0	1.6	4.3	1.3	*4.3	.5	5.7	1.0	3.9	1.5	2.7	.8	3.2	.4
IV.	5.7	.5	9.0	.8	6.8	1.2	4.8	.5	7.0	2.2	6.7	1.1	4.6	.9	5.7	.5	6.6	1.3	4.8	.6	4.5	.4	4.4	.6
V.	5.7	1.6	9.6	7.9	8.8	1.5	5.5	.7	8.8	1.2	7.1	3.9	7.0	.9	6.1	.6	*6.7	.9	8.6	1.7	4.6	1.1	6.2	.9
VI.	*5.7	3.9	11.5	1.8	9.7	1.4	6.0	.8	11.3	1.9	7.5	.6	8.9	.9	6.2	1.1	7.0	1.2	11.1	1.5	7.2	1.0	7.1	1.2
VII.	9.2	1.0	*11.7	6.7	9.8	1.6	6.8	.4	12.2	1.5	8.1	2.6	12.6	5.2	7.5	1.1	8.0	1.2	12.0	2.7	8.4	.7	7.2	2.3
VIII.	9.6	3.6	11.8	2.1	11.4	1.7	7.2	1.0	17.1	2.3	8.5	.8	13.1	1.5	10.3	.8	*8.5	1.4	13.3	.7	8.5	.9	7.5	1.2
IX.	12.1	2.0	12.0	5.3	15.5	2.9	7.8	1.2	17.1	2.5	11.3	1.7	13.4	1.8	11 0	.9	*8.8	.8	14.8	5.6	10.4	1.6	8.0	.3
X.	13.1	1.5	12.2	1.7	15.8	1.5	8.0	.5	18.3	2.5	12.3	1.8	14.1	1.8	13.0	.8	*15.2	1.7	16.9	3.7	11.0	.8	9.5	.6
XI.	14.0	1.3	13.5	1.7	16.4	6.1	10.2	.3	19.3	4.5	13.2	1.3	17.3	5.0	15.2	1.7	*15.7	2.2	17.6	2.5	11.4	1.5	12.3	1.1
XII.	14.6	2.0	14.2	6.2	16.8	3.6	11.0	.3	19.4	3.7	13.7	1.9	17.6	5.2	15.7	2.2	*16.2	2.2	18.0	2.6	15.8	2.4	14.7	1.4
XIII.	14.7	3.1	14.8	8.0	17.8	3.7	13.6	1.1	19.4	4.6	14.8	1.3	*19.1	5.0	19.1	3.1	*16.4	1.5	18.5	4.1	17.5	1.8	17.1	1.5
XIV.	17.4	1.7	18.3	3.5	19.8	3.7	14.2	1.2	19.5	2.9	16.3	1.9	19.7	2.2	20.1	2.6	16.8	2.1	*20.6	2.2	18.0	1.2	17.9	2.3
XV.	19.1	3.4	19.4	4.8	20.7	1.5	14.3	.4	21.5	2.9	19.8	2.0	20.1	2.9	21.2	2.2	18.5	2.3	22.7	3.6	18.6	1.8	18.1	2.3
XVI.	21.5	2.8	19.5	2.2	21.3	3.4	17.0	.7	22.1	2.3	20 2	3.2	20.4	3.4	*21.3	2.7	18.6	2.3	25.5	2.7	19.1	1.6	18.7	1.5
XVII.	21.8	3.1	19.7	5.6	22.0	4.6	21.4	1.4	22.2	1.5	23.9	3.9	20.8	3.1	21.8	2.2	18.8	4.0	26.8	2.7	19.5	1.4	19.2	1.1
XVIII.	*22.8	2.6	21.1	2.3	24.7	2.5	22.7	1.2	*24.8	5.1	27.2	4.0	20.8	3.5	22.4	3.0	19.3	1.5	27.4	4.4	20.5	1.7	19.6	1 6
XIX.	23.1	2.9	21.2	3.7	25.3	6.4	22.9	3.0	26.5	3 5	27.9	3.2	23.0	3.2	24.4	3.0	21.1	1.9	27.5	4.5	21.8	1.5	20.0	3.4
XX.	23.8	2.6	22.1	4.9	25 4	12.7	23.3	2.6	*27.4	4.5	27.9	4.5	24.4	2 3	*25.4	3.7	22.7	3.7	29.9	4.0	22.0	3.6	20.4	1.3

grades and probable errors of the twenty men of science who were assigned positions at the head of each of the twelve sciences. All the anthropologists are thus included in the table, but only two fifths of the astronomers, one fifth of the geologists, etc. In cases in which an individual stands relatively higher in another science a star is attached.

It will be observed that the grades are, as a rule, lower than the positions. As has been stated, the distribution of the judgments or errors in the upper part of the list is 'skewed' in a negative direction, so that the average judgment is lower than the median judgment. Further down the list this tendency disappears, and towards the bottom, not given in the table except for the anatomists and anthropologists, the 'skew' is in the opposite direction. Chauvenet's criterion has been applied; it causes but an insignificant difference in the order, and for statistical purposes the extra calculations involved were superfluous. As has been explained, however, the incidence of a divergent judgment, which might be due to ignorance or prejudice, might be unjust to an individual. The probable errors have been obtained by taking them directly proportional to the average deviation and assuming that there were always ten judgments. In the comparatively few cases where there were less than ten judgments the probable errors of the average are too small, but the differences are not significant. In the measurement of scientific merit, we are concerned not with the probable error of the average, but with the average probable error, which does not depend on the number of cases. Figures for both might be given, but they are so nearly alike and so lacking in significance that it is not worth while.

As the table shows, there are in astronomy, pathology and psychology men who are placed distinctly at the head. In the other sciences those who stand first have grades varying from 1.6 to 3.6. In most cases the differences in grade are less than the probable errors, or not much larger, and the position is not determined to a single place, though it is determined with a theoretically high degree of validity within a very few places. Various groupings occur, which seem to represent the existing conditions of the sciences. Thus there are breaks of two or more units after chemists 4 and 8; physicist 2; zoologists 4 and 6; geologists 2, 5 and 7; botanist 8; mathematicians 3, 6 and 8; pathologists 1, 4, 5 and 9; psychologist 1; physiologists 7 and 9; anatomists 2 and 9, and anthropologist 5. On the other hand, there are cases in which consecutive numbers are bracketed or practically bracketed. Thus mathematicians 4, 5 and 6 have a grade of 5.7. These various groupings appear to be about what the probable errors would lead us to expect.

The probable errors tend to increase as we go down the lists, but with considerable irregularity. This irregularity is in part due to normal variability where the number of observations is small and the average deviations are relatively large, but the larger departures are usually significant, it being easier to assign a position to some men of science than to others. Thus, for example, it is not easy to compare a man who has made one or two important discoveries with a man who has accomplished a large mass of useful work.

The tendency of the probable errors to increase is, however, significant. It is easier to assign the order at the top of the list, and the difficulty increases as we go downward. This subjective fact is measured by the probable errors. It is in part due to less knowledge of those whose work is less important. I know of no way to eliminate this factor or to measure its influence. But the main factor is the real differences between the men, and these are assumed to be inversely as the probable errors and directly as the differences in grade.

In table III. are given all the probable errors averaged in six groups for each of the sciences. In the first and second groups are included one tenth of those in each science, and in the remaining groups one fifth. That is, the probable errors are divided into five equal groups, but the first group is divided into two subgroups, in view of the fact that the probable errors of the first tenth are distinctly smaller than those of the second tenth.

TABLE III. PROBABLE ERRORS IN EACH OF THE SCIENCES, THE MEN OF SCIENCE BEING DIVIDED INTO SIX GROUPS.

	Mathematics.	Physics.	Chemistry.	Astronomy.	Geology.	Botany.	Zoology.	Physiology.	Anatomy.	Pathology.	Anthropology.	Psychology.	Average.	P. E.
CRUDE PROBABLE ERRORS.														
I. {	1.8	3.8	2.5	.4	1.7	1.6	2.4	.4	.4	.9	.2	.5		
	2.2	4.0	5.7	.8	3.5	2.7	4.1	.9	.9	3.0	.3	.9		
II.	4.1	8.5	6.9	1.3	5.2	4.8	6.8	2.0	1.3	3.7	.9	1.8		
III.	4.5	10.1	13.4	3.8	6.7	7.6	9.8	3.0	2.1	6.8	1.6	4.2		
IV.	6.0	9.4	15.0	3.6	7.0	8.7	9.6	2.9	2.7	5.9	1.6	5.8		
V.	6.4	8.5	13.9	3.2	6.7	8.3	9.6	2.9	3.4	6.0	2.0	6.2		
PROBABLE ERRORS CORRECTED FOR THE RANGE.														
I. {	1.3	3.1	2.0	.4	.9	1.3	1.9	.3	.2	.5	.2	.4		
	1.8	2.8	3.4	.9	3.6	1.7	3.3	.7	1.7	2.8	.3	.9		
II.	3.0	6.2	5.0	.8	7.0	4.2	5.3	1.5	.8	3.3	.6	1.9		
III.	7.1	14.0	16.4	6.3	6.4	8.2	11.3	2.9	3.6	8.6	.9	1.8		
IV.	7.3	28.5	22.7	3.9	8.3	8.3	15.3	2.6	2.6	12.6	3.2	6.4		
V.	6.2	24.8	25.3	4.6	7.3	15.6	17.0	4.2	3.8	6.2	2.1	10.7		
THE SAME REDUCED TO A COMMON STANDARD FOR THE THOUSAND MEN OF SCIENCE.														
I. {	16	21	11	8	9	13	13	8	8	8	10	8	**11.1**	.8
	22	19	19	18	36	17	22	18	68	47	15	18	**26.6**	2.9
II.	37	41	29	16	70	42	35	38	32	55	30	38	**38.6**	2.2
III.	89	93	94	126	64	82	75	73	144	143	45	36	**88.7**	6.4
IV.	91	190	129	78	83	83	102	65	104	210	160	128	**118.6**	9.1
V.	78	165	145	92	73	156	113	105	152	103	105	214	**125.1**	8.4

In the middle part of the table the probable errors have been adjusted to the ranges covered by each group, and in the lower part these figures have been reduced to a common standard of a thousand, so that the results for the different sciences may be comparable.

If the range of ability is the same in each science and if the difficulty of assigning the order in each science is the same, then the figures in the lower third of the table should tend to be the same in the different sciences. As the averages include from 2 to 35 cases, they are subject to a probable error which varies considerably. Thus, to take, for example, an intermediate case—the botanists—the probable errors of the six entries in the upper part of the table are: 0.25, 0.33, 0.18, 0.28, 0.22, 0.25. They thus seem to be determined with considerable validity. When the probable errors are adjusted for the ranges, a considerable 'chance' variation is introduced. If the figures were broken up into groups of different sizes, the results would be different. The figures in the last three groups of each of the sciences seem scarcely to be significant of real differences in the sciences, though they to a certain extent measure the actually existing conditions.

The figures in the table give the validity with which the positions are determined, and at the same time measure the relative differences between the men in the several groups. Thus the first tenth of the chemists have on the average their positions determined relatively to other chemists with a probable error of two places and the last fifth with a probable error of 25 places. In relation to the first hundred scientific men, a chemist in this group has his position determined on the average (apart from the error due to the interpolation) with a probable error of 11 places, whereas in relation to the last 200 scientific men, the place is determined with a probable error of 145 places.

The figures also show that the average differences between the chemists who are in the first tenth are about eight times as great as between the chemists towards the middle of the list and about twelve times as great as between the chemists towards the bottom of the list.

As has been stated, there are considerable variations in the figures for the different sciences. In general, however, those in the first hundred differ from each other about ten times as much as those in the last four hundred, among whom there are no constant differences. It is scarcely safe to draw inferences from the variations in the different groups and in the different sciences. If the probable errors in one science were consistently higher than in another, it would mean that in the former science it is more difficult to make the arrangement, which might be due to greater diversity in the work to be compared or to greater similarity in the men. The greater similarity in the men would probably be due to there having been relatively too many men included in that science. But such consistent differences do not appear. Thus the psychologists have the largest probable error in the last group, but the smallest in the third group, and the mathematicians have the second smallest probable error in the last group, but the second largest in the first group. In so far as these figures are significant, they might mean that our able psychologists are more able than our able mathematicians, whereas our lesser psychologists are less able than our lesser mathematicians. It is probably true that our leading psychologists would compare more favorably with those of Germany, France and Great Britain than our leading mathematicians, but inferences as to the variation in the distribution of ability in the different sciences can not be made from the data at hand with any considerable degree of validity. It would, however, be of interest to have comparable data for different nations and for different periods.

The workers in the twelve sciences have been combined into one series by interpolation, it being assumed that the range of ability in each science is the same. The probable errors have at the same time been increased to correspond with a thousand cases, as shown in table III. This makes the probable errors relatively correct, but does not allow for the additional chance variations caused by the interpolation. The list is of considerable interest, as it enables us to compare with more or less accuracy men of science working in diverse directions.

The order, grades and probable errors of the fifty who stand first are given to illustrate the method. We can thus say that the work of a certain physicist is equal in value to the work of a certain zoologist, or that a certain

TABLE IV. THE ORDER, THE SCIENCE, THE GRADE AND THE PROBABLE ERROR OF EACH OF THE FIRST FIFTY MEN OF SCIENCE ON THE LIST.

Order.	Science.	Grade.	P. E.	Order.	Science.	Grade.	P. E.	Order.	Science.	Grade.	P. E.
I.	Astron.	?	0	XVIII.	Chem.	38.8	6.9	XXXV.	Physiol.	65.0	7.0
II.	Path.	?	0	XIX.	Math.	41.3	37.1	XXXVI.	Psychol.	65.0	7.3
III.	Psychol.	?	0	XX.	Math.	46.3	8.7	XXXVII.	Path.	65.0	24.7
IV.	Physics.	10.7	4.8	XXI.	Zool.	46.7	6.0	XXXVIII.	Chem.	65.1	9.9
V.	Zool.	18.0	1.3	XXII.	Physiol.	50.0	7.7	XXXIX.	Bot.	67.8	10.6
VI.	Chem.	20.5	3.2	XXIII.	Bot.	50.0	15.9	XL.	Geol.	70.0	21.8
VII.	Zool.	21.3	6.9	XXIV.	Chem.	50.2	8.3	XLI.	Math.	71.3	5.9
VIII.	Physics.	21.3	18.2	XXV.	Geol.	54.4	16.2	XLII.	Math.	71.3	19.6
IX.	Geol.	25.0	4.7	XXVI.	Chem.	55.4	7.8	XLIII.	Bot.	71.3	39.2
X.	Chem.	25.1	2.4	XXVII.	Chem.	56.0	9.3	XLIV.	Bot.	75.5	6.2
XI.	Zool.	28.7	8.6	XXVIII.	Physics.	58.0	17.7	XLV.	Physics.	76.7	11.8
XII.	Bot.	29.0	8.1	XXIX.	Zool.	59.3	6.2	XLVI.	Physics.	78.7	14.2
XIII.	Zool.	30.7	5.9	XXX.	Physics.	60.0	5.2	XLVII.	Path.	80.0	10.7
XIV.	Math.	31.3	7.0	XXXI.	Psychol.	60.0	9.8	XLVIII.	Physics.	80.0	35.3
XV.	Chem.	31.4	9.8	XXXII.	Anat.	60.0	12.3	XLIX.	Bot.	81.1	27.2
XVI.	Bot.	33.0	5.3	XXXIII.	Physics.	64.0	53.4	L.	Physics.	81.3	11.2
XVII.	Geol.	33.3	4.7	XXXIV.	Path.	65.0	4.2				

chemist has one chance in four of being as competent as a certain pathologist, a result that would not be possible by direct comparison. The various factors which limit the exactness of the method should be kept in mind, but we have at least the beginning of a method which with further effort can be made more accurate. Similar methods can be applied to comparing the value of performance in fields even more diverse than the several sciences.

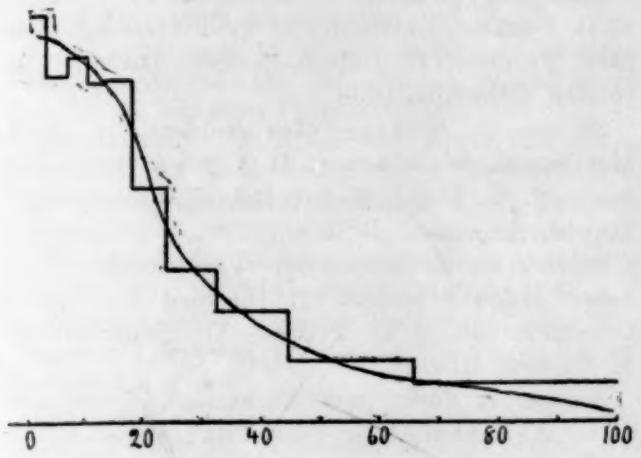

FIG. 2. Distribution of the thousand men of science.

In the accompanying curve—which is based on substantially the same figures as are given in table III., except that a man is given a position only in the science in which he stands the highest—is shown the distribution of the thousand men of science. The 1,000 scientific men are divided into ten groups, the range of eminence or merit covered by each hundred being proportional to the space it occupies on the axis of the abscissas, and the number of each degree of ability being proportional to the ordinates. The range of merit covered by each hundred becomes smaller and there are more of each degree of merit as we pass from the first to the second hundred and so on for the first five hundred, after which the differences become very small. The first hundred men of science cover a range of merit about equal to that of the second and third hundreds together, and this again is very nearly equal to the range covered by the remaining seven hundred. The average differences between the men in the first hundred are about twice as great as between the men in the second and third hundreds, and about seven times as great as between the men in the remaining groups. Or the differences among the first hundred are almost exactly ten times as great as among the last five hundred, who differ but little among themselves. It would be desirable to compare this distribution with that of the normal probability integral and with the salaries paid to scientific men, but the data are not as yet at hand.

J. MCKEEN CATTELL.

COLUMBIA UNIVERSITY.

NOTES ON ORGANIC CHEMISTRY.

OPTICALLY ACTIVE COMPOUNDS WHICH CONTAIN NO ASYMMETRIC ATOM.

OPTICAL activity, or the power of causing deviation in the path of a ray of polarized light, is shown by hundreds of organic compounds, all of which contain one or more asymmetric atoms of carbon, nitrogen, sulphur, etc. A carbon atom is asymmetric when it is linked to four, and a nitrogen atom when it is linked to five dissimilar atoms or groups. The only exception to the above connection of asymmetry and optical activity is the compound inosit, which has the formula

$$HOCH<\begin{matrix}CH(OH)CH(OH)\\CH(OH)CH(OH)\end{matrix}>CHOH$$

and is said to exist in two modifications of opposite activity. Quite recently a second exception has been discovered by W. Marckwald and R. Meth.[1] Their starting point is 1-methylcyclohexanone-(4),

$$(4)\qquad CH_2CH<\begin{matrix}CH_2CH_2\\CH_2CH_2\end{matrix}>CO,$$

from which, by a few simple steps, they obtain the corresponding acetic acid derivative. This is called 1-methylcyclohexylidene-(4)-acetic acid,

$$CH_2CH<\begin{matrix}CH_2CH_2\\CH_2CH_2\end{matrix}>C:CHCOOH.$$

By means of its chinchonine salts this acid is resolved into two new acids of opposite, and practically equal optical activity, just as is the

[1] *Ber. d. Chem. Ges.*, **39**, 2404 (1906).

case with the corresponding tartaric acids, for example.

Should these observations be confirmed it can hardly fail to modify profoundly our conception of the spatial relations and stereochemistry of organic compounds. The authors believe that their new compounds are similar, spatially, to allene (isoallylene) derivatives of the type,

$$\overset{a}{b}>c:c:c<\overset{c}{d},$$

which might exist in two forms, each one of which would be the mirror image of the other, as was pointed out by Van't Hoff in his classical work on the spatial relations of the atom.

J. Bishop Tingle.

Johns Hopkins University,
October, 1906.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

The American Association for the Advancement of Science and the national scientific societies named below will meet in New York City during convocation week, beginning on December 27, 1906.

American Association for the Advancement of Science.—December 27–January 1. Retiring president, Professor C. M. Woodward, Washington University, St. Louis, Mo.; president-elect, Professor W. H. Welch, The Johns Hopkins University, Baltimore, Md.; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Dr. John F. Hayford, U. S. Coast and Geodetic Survey, Washington, D. C.; secretary of the council, President F. W. McNair, Houghton, Mich.

Local Executive Committee.—J. J. Stevenson, chairman, C. C. Adams, Charles Baskerville, Franz Boas, N. L. Britton, H. C. Bumpus, Chas. A. Conant, Simon Flexner, Wm. J. Gies, Wm. Hallock, Alex. C. Humphreys, G. S. Huntington, Edward Kasner, Henry F. Osborn, C. L. Poor, Clifford Richardson, E. B. Wilson, Frederick J. E. Woodbridge, J. McKeen Cattell, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Edward Kasner, Columbia University; secretary, Professor L. G. Weld, University of Iowa, Iowa City, Iowa.

Section B, Physics.—Vice-president, Professor W. C. Sabine, Harvard University; secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C, Chemistry.—Vice-president, Mr. Clifford Richardson, New York City; secretary, Professor Charles L. Parsons, New Hampshire College of Agriculture, Durham, N. H.

Section D, Mechanical Science and Engineering.—Vice-president, Mr. W. R. Warner, Cleveland, O.; secretary, Professor Wm. T. Magruder, Ohio State University, Columbus, Ohio.

Section E, Geology and Geography.—Vice-president, Dr. A. C. Lane, Lansing, Mich.; secretary, Dr. Edmund O. Hovey, American Museum of Natural History, New York, N. Y.

Section F, Zoology.—Vice-president, Professor E. G. Conklin, University of Pennsylvania; secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G, Botany.—Vice-president Dr. D. T. MacDougal, Washington, D. C.; secretary, Professor F. E. Lloyd, Desert Botanical Laboratory, Tucson, Arizona.

Section H, Anthropology.—Vice-president, Professor Hugo Münsterberg, Harvard University; secretary, George H. Pepper, American Museum of Natural History.

Section I, Social and Economic Science.—Mr. Chas. A. Conant, New York City; secretary, Dr. J. F. Crowell, Bureau of Statistics, Washington, D. C.

Section K, Physiology and Experimental Medicine.—Vice-president, Dr. Simon Flexner, The Rockefeller Institute for Medical Research; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

The American Society of Naturalists.—December 28. President, Professor William James, Harvard University; secretary, Professor W. E. Castle, Harvard University.

The Astronomical and Astrophysical Society of America.—December 28. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

The American Physical Society.—President, Professor Carl Barus, Brown University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Mathematical Society.—December 28, 29. President, Professor W. F. Osgood, Harvard University; secretary, Professor F. N. Cole, Columbia University.

The American Chemical Society.—December 27–January 2. President, Professor W. F. Hillebrand, U. S. Geological Survey; secretary, Dr. William A. Noyes, the Bureau of Standards, Washington, D. C.

The Geological Society of America.—December 26–29. Acting president, Professor W. M. Davis, Harvard University; secretary, Professor Herman L. Fairchild, Rochester, N. Y.

The Association of American Geographers.—December 31–January 1. President, Cyrus C. Adams, New York City; secretary, Albert P. Brigham, Colgate University.

The American Society of Zoologists.—December 27, 28, 29. President (Eastern Branch), Professor W. E. Castle, Harvard University; secretary, Professor H. S. Pratt, Haverford College. President (Central Branch), Professor C. C. Nutting, University of Iowa; secretary, Professor T. G. See, University of Michigan.

The Association of Economic Entomologists.—President, A. H. Kirkland, Malden, Mass.; secretary, A. F. Burgess, Columbus, O.

The Society of American Bacteriologists.—President, Dr. E. F. Smith, U. S. Department of Agriculture; secretary, Professor S. C. Prescott, Massachusetts Institute of Technology.

The American Physiological Society.—December 27, 28, 29. President, Professor W. H. Howell, the Johns Hopkins University; secretary, Professor Lafayette B. Mendel, 18 Trumbull St., New Haven, Conn.

The Association of American Anatomists.—December, 27, 28, 29. Professor G. Carl Huber, 333 East Ann St., Ann Arbor, Mich.

The Botanical Society of America.—December 27, 28, 29. President, Dr. F. S. Earle; secretary, Dr. William Trelease, Missouri Botanical Garden, St. Louis, Mo.

The American Psychological Association.—December 27–28. President, Professor James R. Angell, University of Chicago; secretary, Professor Wm. Harper Davis, Lehigh University.

The American Philosophical Association.—December 27–29. President, Professor William James, Harvard University; secretary, Professor John Grier Hibben, Princeton University.

The American Anthropological Association.—December 27–January 3. President, Professor F. W. Putnam, Harvard University; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—December 27–January 3. President, Dr. A. L. Kroeber, University of California; secretary, W. W. Newell, Cambridge, Mass.

New York State Science Teachers Association.—December 26, 27. Secretary, John F. Woodhull, Teachers College, Columbia University.

SCIENTIFIC NOTES AND NEWS.

A MEETING to commemorate the life and services of Samuel Pierpont Langley, secretary of the Smithsonian Institution from 1887 to 1906, will be held in the lecture room of the United States National Museum on Monday evening, December 3, at 8:15 o'clock. The following addresses will be delivered: 'Introductory Remarks,' by the chancellor of the Smithsonian Institution, the Honorable Melville W. Fuller, Chief Justice of the United States; 'Memorial on Behalf of the Board of Regents,' by the Honorable Andrew D. White, LL.D.; 'Mr. Langley's Contributions to Astronomy and Astrophysics,' by Professor E. C. Pickering, director of the Harvard College Observatory; 'Mr. Langley's Contributions to Aerodynamics,' by Octave Chanute, Esq., of Chicago.

THE Alumni Association of New York University has planned a testimonial to Professor J. J. Stevenson on the completion of thirty-five years of service as professor of geology in the university. A dinner will be given in his honor on December 7 at the Hotel Astor, and a silver loving cup will be presented to him.

THE formal presentation of the new portrait of President James B. Angell, of the University of Michigan, will take place on Saturday afternoon, December 8, in University Hall, Ann Arbor. This painting, which is by William M. Chase, of New York, is the gift to the university of the students, faculty and alumni. The picture will be presented to the university by Professor Henry M. Bates, of the law department, on behalf of all the thousands of donors, while the formal acceptance will be made by Regent Loyal E. Knappen. A formal address will also be delivered on that occasion by Professor Jeremiah W. Jenks, of Cornell University, an alumnus of the university.

SIR VICTOR HORSLEY, who has been connected with University College, London, as a student and as a teacher for thirty years, has resigned his professorship of clinical surgery and his position as surgeon to the hospital on account of increasing public and private professional duties. The council, in accepting his resignation, adopted unanimously the following resolution: "That the council, having received with great regret Sir Victor Horsley's resignation of his professorship of clinical surgery and his position of surgeon to University College Hospital, whereby his offi-

cial connection with the college is severed, desire to put on record their recognition of his long service to the college and the distinction he has conferred upon it by his eminence as a scientific investigator."

According to *Nature*, the honors conferred by King Edward on the occasion of his sixty-fifth birthday appear to be mainly for political services, and there is little recognition of the claims of science. Mr. John Tweedy, president of the Royal College of Physicians, has received the honor of knighthood; Colonel R. C. Hellard, director-general of the Ordnance Survey, and Mr. F. G. Ogilvie, principal assistant secretary (Technology and Higher Education in Science and Art) Board of Education, have been appointed Companions of the Order of the Bath; Colonel D. A. Johnston, formerly drector-general of the Ordnance Survey, has been appointed a Knight Commander of the Order of Saint Michael and Saint George; Professor R. W. Boyce, F.R.S., has received the honor of knighthood; and Dr. J. M. Lang, vice-chancellor and principal of the University of Aberdeen, has been appointed a Commander of the Royal Victorian Order.

Dr. William Osler, of Oxford University, will sail for America on November 28, to visit Toronto, Baltimore and other cities.

Dr. W. A. Kellerman, of the Ohio State University, will shortly make his third collecting trip to Guatemala for the purpose of collecting parasitic fungi, returning next March or April. He will be accompanied by two student assistants, and will be glad to execute any minor commissions of specialists so far as possible.

Dr. Mel. T. Cook, who recently resigned his position as chief of the department of plant pathology of the Central Agricultural Experiment Station of Cuba, expects to devote several months to studies at the New York Botanical Garden.

Dr. J. C. W. Frazer, of the Johns Hopkins University, has been appointed head of the research department of the United States Fuel-testing Plant, temporarily located at St. Louis, Mo.

Dr. E. B. Copeland, who has been connected with the government laboratories at Manila, has been elected horticulturist of the West Virginia station and will enter on his work about the middle of November. He is a graduate of Leland Stanford University, and previous to going to Manila was instructor in botany in this university.

Dr. J. K. Small, of the New York Botanical Garden, left for Southern Florida, on October 23, accompanied by Mr. J. J. Carter. Dr. Small will continue his investigations of the flora of this region.

Dr. W. Morris Travers, F.R.S., late professor of chemistry at Bristol University College, left Marseilles, on November 2, in the mail steamer *Victoria*, for Bangalore, to take up his work as first director of the Indian Institute of Science, to which he has been appointed by Mr. Morley, on the recommendation of the Royal Society.

The Gedge prize of Cambridge University has been awarded to Patrick Playfair Laidlaw, B.A., of St. John's College, for his essay entitled, 'Some Observations on Blood Pigments.'

Dr. E. A. Minchin, professor of protozoology in the University of London, delivered his inaugural address at the university on November 15. The subject was 'The Scope and Problems of Protozoology.'

Dr. William H. Chandler, emeritus professor of chemistry at Lehigh University, died on November 23, aged sixty-five years.

There will be a civil service examination on December 12–13, to fill a vacancy in the position of miscellaneous piecework computer in the Naval Observatory. The department states that miscellaneous computers are paid by the hour, and earn from $800 to $1,000 per annum. An examination will also be held for the position of forest assistant in the Forest Service at a salary of $900 a year.

The nineteenth annual meeting of the Geological Society of America will be held in New York City on December 26–29. The opening session on Wednesday will take place at Columbia University, Schermerhorn Hall, and will be called to order at 2 o'clock P.M.,

by Acting-President Davis. There will be no session on Thursday, the opening day of the American Association for the Advancement of Science, unless the council decides otherwise. The sessions of Friday and Saturday will be held at the American Museum of Natural History, 77th Street and Central Park, West. The customary dinner will probably occur on Friday evening, December 28. Under the rule securing rotation of subjects the order of papers at this meeting will be as follows: physiographic, cartographic, economic, physical and structural, glacial, stratigraphic, areal, paleontologic, petrographic. The meeting of the Cordilleran Section will be held on December 28 and 29, at Stanford University, California.

THE American Breeders' Association will hold its regular winter meeting at Columbus, Ohio, January 15–18, 1907. The sessions will be held at the university and board of trade buildings.

THE annual public meeting of the Academic Chambers composing the Institute of France was held on October 25, under the presidency of M. Gedhardt, who, after an allusion to the members of the institute who had died since the last meeting, announced that the linguistic prize had been won by Professor Jespersen, of the University of Copenhagen, for a treatise on comparative philology.

THE foundation-stone of the new German National Museum at Munich was laid by the German Emperor on November 13, in the presence of a distinguished and representative company.

THE collection of shells of British Mollusca, comprising about 5,600 specimens, belonging to the late Mr. Richard Rimmer, has been presented to the natural history department of the Royal Scottish Museum, Edinburgh.

THE Carnegie Museum has acquired by purchase a fine skull, with the horn-cores and horns ensheathing them, of *Bison crassicornis* Richardson. It was found in gold-bearing gravel at the bottom of a mine on Sulphur Creek forty miles east of Dawson. Associated with it were the remains of a mammoth. It is probably the most perfect specimen representing this huge creature which has thus far been discovered.

THE fire which recently occurred at the Carnegie Institute in Pittsburg was confined to the new engine-room, and the only damage done was to the great switchboard which runs along the north wall of the room. The splendid collections of the institute were never for one moment in any danger, as the building is practically fireproof. The damage consisted in the charring and burning of the insulation of the wires on the switchboard, which had not yet been taken over from the firm which had contracted for the installation. The origin of the fire is a mystery, as there was no current on any of the wires and there could have been no crossed wires. The loss will amount to a heavy sum, but the delay in completing the electrical equipment of the building which must result is a still more serious matter.

THE paleontological expedition of the Carnegie Museum to northwestern Wyoming, undertaken during the past summer under the direction of Mr. Roy L. Moodie, fellow in paleontology of the University of Chicago, assisted by Mr. E. B. Bartholow of the University of Kansas, has secured what is perhaps the best collection of plesiosaurian and amphicœlian crocodile remains ever brought together in any American museum. The beds explored were the Hailey shales of the upper Benton Cretaceous, described by Professor Williston in SCIENCE for October 20, 1905, and the explorations were made under his advice. The material collected, weighing more than five tons, includes two nearly complete skeletons, with excellent skulls, of plesiosaurs, one of the *Trinacromerum* type, the other of a broad-headed, short-necked form; about twenty-five other specimens of plesiosaurs, representing most parts of the skeleton; several specimens of hollow-boned amphicœlian crocodiles, probably either *Teleorhinus* or *Hyposaurus,* one of them a nearly complete skeleton with skull; a number of excellent turtles having well ossified carapaces and plastrons, perhaps allied to *Toxochelys,* and doubtless new to science; a small reptilian skull a few inches in length, of undetermined

relationships; and some fish remains. This material when worked out will add very materially to our knowledge of the marine Cretaceous fauna, and especially to our knowledge of the plesiosaurs of America.

Yale University has appropriated a sum sufficient to cover the cost of publishing in book form the Mathematical Society's colloquium in New Haven last September. This is to be issued as a Yale publication. Copies will be forwarded to all subscribing members of the society and the remainder of the edition will be placed at the disposal of the librarian of the university for exchange and other purposes.

With the view of bringing together the cattle and most of the deer in the London Zoological Gardens the authorities have constructed a range of buildings in the south garden, between the lion-house and the pheasantries. The former deer-sheds have been improved and others built at the eastern end, the latter being furnished with paddocks corresponding to those of the older structure. South of this, but under the same roof, the new cattle-sheds have been put up, and the land cleared by pulling down the old ones has been thrown into the five large paddocks.

UNIVERSITY AND EDUCATIONAL NEWS.

President John E. Goucher, of the Woman's College, Baltimore, Md., has deeded to the college his private residence for use as an administration building.

An anonymous gift of $50,000 has been received by Yale University to establish the John Slade Ely professorship in the medical school in memory of Professor Ely, who died in the spring.

A new science hall at the University of Mississippi is in process of construction. This will be a large three-story building, and it is hoped that it will be completed in time for the geological and other collections to be transferred next summer. Other buildings under construction are a hospital and four residences for professors.

The annual meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching was held at the offices of the foundation in New York on November 20. The executive officers of the foundation are Dr. Henry S. Pritchett, president, and T. Morris Carnegie, treasurer, while the general officers of the board itself are: *Chairman,* President Eliot; *vice-chairman,* President Jordan; *secretary,* President Thwing.

We learn from the *Harvard Bulletin* that the Harvard Graduate School of Applied Science, which was established last spring, begins its work this fall with an enrolment of thirty students. Courses are offered leading to degrees in the following subjects: civil engineering, mechanical engineering, electrical engineering, mining, metallurgy, architecture, landscape architecture, forestry, physics, chemistry, zoology, geology. The school will differ from the Lawrence Scientific School in that a bachelor's degree will be required for admission, and original work will be done, as is true of the Graduate School, in relation to the department of arts and sciences. The new institution will give to Harvard students five-year courses in both departments, the first three in each case being undergraduate.

The resignation of Professor James Lee Love as secretary of the Lawrence Scientific School of Harvard University was received and accepted, to take effect November 12, 1906.

The establishment of a chair of economic geology in the Sheffield Scientific School of Yale University is announced, with the appointment of Professor John Duer Irving, professor of geology at Lehigh University, as the first incumbent; Dr. G. R. Wieland has been appointed lecturer in paleobotany.

Dr. Herbert J. Webber, director of plant-breeding investigations in the Department of Agriculture, has been appointed professor of plant biology in the College of Agriculture of Cornell University.

The council of King's College, London, has appointed Mr. Arthur Whitfield, M.D., professor of dermatology.